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GEOPHYSICS.—*Earthquakes associated with the 1933 eruption of Mauna Loa, Hawaii.*[1] AUSTIN E. JONES, Geological Survey. (Communicated by T. A. Jaggar.)

A relation between volcanic outbreaks and accompanying earthquakes has long been noted. In this connection there is presented here a series of 77 earthquake locations recorded during the 11 months preceding the Mauna Loa eruption of December 2, 1933, followed by 19 locations recorded during and after the outbreak.

During the year 1933, a double network of seismograph stations was maintained by the U. S. Geological Survey and the Hawaiian Volcano Research Association as follows:

TABLE 1.—SEISMOGRAPH STATIONS IN HAWAII IN 1933.

Name	Map symbol	Name	Map symbol
Hawaiian Volcano Observatory	V	Hilo[a]	H
Uwekahuna	U	Kealakekua[a]	K
Halemaumau (Pit)	P	Waikii	W

[a] Two of these stations were kept going by volunteers.

The main station of this group (V) recorded 232 earthquakes, about 1,800 spasmodic tremors, and about 2,300 minutes of harmonic tremor. Spasmodic tremors are in many cases very small records of the secondary waves of small local shocks and in other cases may have been generated by moving lava. The harmonic or continuous volcanic tremor usually accompanies eruptions and is thought to be generated by the flowing lava, much as similar vibrations elsewhere are generated by water-falls.

About 40 per cent or 96 earthquakes were located. Those in Kilauea crater have been left out to avoid crowding. In July 1933, 35 quakes

[1] Published by permission of the Director of the U. S. Geological Survey. Received July 6, 1934.

and tremors were located in and about Kilauea crater. About half of the located earthquakes were felt. It is rarely possible to locate an earthquake in Hawaii by drawing isoseismals because only the fringe of the island below 4,000 feet elevation is settled.

The earthquakes are located by distances from the several stations shown on the map. The stations used in finding the epicenter are listed in the table for each numbered earthquake. Poor epicenters are located with the aid of only one or two stations. Good epicenters are located from three or four stations.

Depths less than 10 kilometers are not listed. The errors in depth are large when near the surface of the earth and far from a station. It is believed that other depths are too small. They should indicate any tendency of earthquakes to get progressively shallower or deeper.

The distances from each station are found by measuring the "duration of the preliminary"[2] for each earthquake from each station record. The laws connecting the S–P time interval and the distance as found for the Hawaiian islands are:

$$S_g - P_g; \ldots\ldots \quad t_g = 5.7 + 0.143\Delta - 5.7e^{-0.3\Delta}$$
$$S^* - P^*; \ldots\ldots \quad t^* = 1.7 + 0.098\Delta$$
$$S_n - P_n; \ldots\ldots \quad t_n = 0.3 + 0.092\Delta$$

where t = time in seconds and Δ = distance in kilometers.[3] These distances are first used on a mechanical focus finder,[4] which consists of an inverted relief map with distances on strings from each station. The epicenter located in this way is checked by a graphical method,[5] and the epicenter plotted on the map. In 1932 one focus was located that appeared deeper than any in the table, namely 70 kilometers. A slight tendency for the quakes to get progressively shallower up to the time of the eruption was noted.

Approximately one seventh of the located epicenters were under the sea, usually on the submarine slopes of the island. The first one in the table occurred in 15,000 feet of water at the SE edge of a 6,000 foot rise in the sea floor. Numbers 0, 2A and 61 occurred where the sea is 16,000 to 18,000 feet deep.[6] Approximately one third of the epicenters were on the quiescent volcanoes of Hualalai, Mauna Kea,

[2] S-P interval in seconds.
[3] Unpublished manuscript.
[4] Volcano Letter No. 351, published by the Hawaiian Volcano Research Association.
[5] Physics of the Earth, Seismology. National Research Council. p. 162.
[6] It is interesting to note that these earthquakes originating under the sea bottom, where the island materials consisting of piled-up lava flows are very thin or even lacking, give rise to multiple P and S waves. This indicates a layered condition of the sea bottom near the island chain. The numbers of P and S waves found in each of the above four quakes is 3, 2, 3, and 4.

and Kohala. The remainder were on the active volcanoes of Kilauea and Mauna Loa.

A small number of the located earthquakes of 1933 occurred on the known island rifts. It is to be expected that the rifts would show greater seismic activity in the neighborhood of volcanic centers.

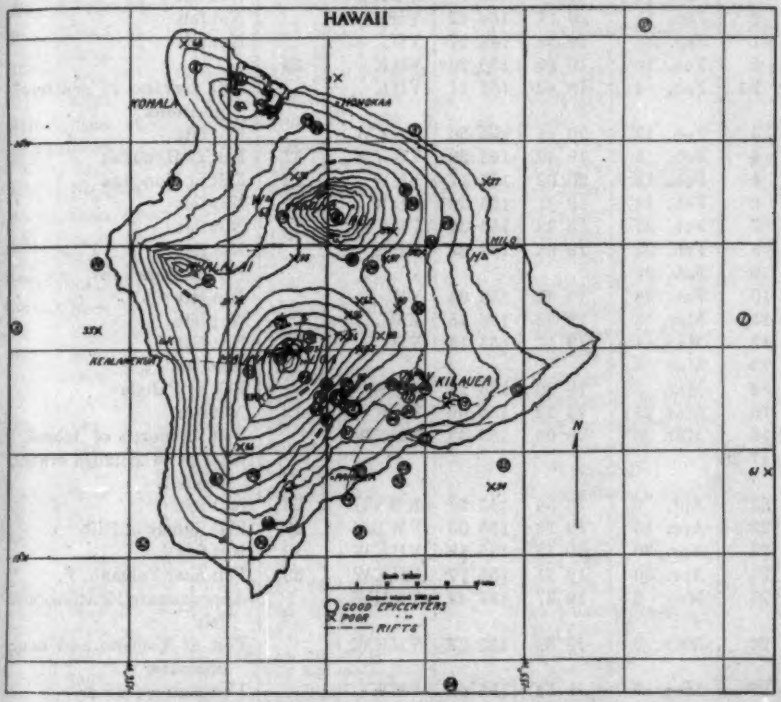

Fig. 1—Map of the Island of Hawaii giving location of recorded earthquakes preceding and following the 1933 eruption of Mauna Loa.

Groups of epicenters fell in lines to the SE, NE, and N of the summit crater of Mauna Loa. These lines of epicenters may define rifts. No topographic features have been found to indicate that these are rift lines.

A number of earthquakes occurred within craters. More than 40 small shocks, chiefly instrumental, were recorded from Kilauea crater during the year. At times these crater shocks definitely precede and accompany eruptions. More often they are caused by movements deep in the volcano. These movements are sometimes accompanied by surface changes such as opening of cracks and changes of tilt.

TABLE 2.—EARTHQUAKES PRECEDING AND FOLLOWING THE 1933 ERUPTION OF MAUNA LOA.

Map Nos.	Date	Lat N.	Long. W.	Recording Stations	Depth km.	Remarks
		° ′	° ′			
	Jan. 11	19	158	VHKW		Not felt
0	Jan. 11	20 17	154 42	VHK		Not felt
1	Jan. 31	19 34	154 27	VH		Not felt
2	Feb. 10	19 22	155 26	VHK	53	
2A	Feb. 4	18 42	155 11	VHK		Felt by few in scattered positions
3	Feb. 13	20 11	155 50	VHKW		Not felt
4	Feb. 16	19 49	155 28	VHKW	37	Felt at Honokaa
5	Feb. 18	20 02	155 17	VHW	12	Felt at Honokaa
6	Feb. 18	19 31	155 36	BKW	57	Not felt
7	Feb. 21	19 23	155 31	VHKW	28	Not felt
8	Feb. 22	19 03	155 25	VHK		Not felt
9	Feb. 27			V		Felt at Honokaa
10	Feb. 28	19 43	156 05	VK		Not felt
11	Mar. 8	19 33	156 18	KW		Not felt
12	Mar. 8	19 17	155 15	VH	10	Not felt
13	Mar. 8			V		Near no. 12
14	Mar. 9	19 08	155 27	VHW		Felt at Pahala
15	Mar. 25	19 22	155 09	VHK	13	Not felt
16	Mar. 28	20 09	155 43	VHKW		Felt in north of Island
17–20						Near or in Kilauea crater, not felt.
21	Apr. 9	19 54	155 53	KWVH	23	Not felt
22	Apr. 16	19 13	155 03	VWHK	37	Felt lightly in Hilo
23	Apr. 30	19 13	155 18	VHKW	19	Not felt
24	Apr. 30	19 21	155 17	VHKW	33	Felt near Volcano, V.
25	May 2	19 37	155 43	VHKW		Approximate location, not felt
26	May 9	19 32	155 27	VHKW		Felt at Volcano and near epicenter
27	May 17	19 54	155 06	VHW		Felt near epicenter
28	May 20	19 32	155 22	VW		Not felt
29	May 24	19 49	155 37	VHKW		Felt at W & Honokaa
30	May 24	20 02	155 31	VHW		Felt in Honokaa
31	May 25	19 55	155 35	HKW		Not felt
32	May 27	19 25	155 27	VHKW		Felt lightly
33	May 28	19 33	156 05	VK		Felt near epicenter
34	June 7	19 53	155 28	VHW		Not felt
35	June 9	19 27	155 42	VHK	10	Slopped water from tanks near epicenter
36	June 15	19 36	155 16	VHK		Not felt
37	June 19	19 13	155 25	VHKW	10	Not felt
38	June 20			V		Near or in Kilauea crater
39	June 22	20 03	155 33	VHKW	11	Felt near epicenter
40	June 25	19 24	155 15	VUP		Not felt
41	June 29	19 40	155 48	VHKW		Felt lightly over Island
42	July 2			V		In Kilauea crater, not felt
43	July 14			V		In Kilauea crater, not felt

TABLE 2.—*Continued.*

Map No.	Date	Lat. N.	Long. W.	Recording Stations	Depth km.	Remarks
		° ′	° ′			
44	July 19	19 20	155 20	VHW	40	Felt in Hilo
45	July 20			V		In Kilauea crater, not felt
46	July 22			V		In Kilauea crater, not felt
47	July 31	19 20	155 30	VHK	16	Felt sharply near epicenter
48	Aug. 7	19 05	155 39	VK		Felt near epicenter
49	Aug. 31	19 48	155 12	VHKW	39	Not felt
50	Sept. 2	19 02	155 40	VHK		Not felt
51	Sept. 7	19 18	155 27	VHK	45	Felt
52	Sept. 11	19 02	155 58	VHK		Not felt
53	Sept. 11	19 23	155 28	VHK	11	Felt near epicenter
53A	Sept. 14	19 23	155 40	VK		Not felt
54	Sept. 14	19 10	155 05	VH		Not felt
55	Sept. 16	19 43	155 35	VH		Not felt
56	Sept. 20	19 35	155 27	VH		Not felt
57	Sept. 21	19 24	155 01	VPU		Not felt
58	Sept. 26	19 42	155 23	VHK	11	Felt slightly
59	Sept. 28	19 22	155 27	VHK	15	Felt near epicenter
60	Sept. 30	19 43	155 26	VKW		Not felt
61	Oct. 13	19 12	154 23	VH		Felt slightly in Hilo
62	Oct. 19	19 37	155 25	VHKW	15	Felt slightly in Hilo
63	Oct. 20	19 22	155 12	P		Felt near epicenter
64	Oct. 21	19 21	155 31	VHK		Felt generally
65	Oct. 21	19 25	155 30	VHK	15	Felt generally
66	Nov. 10	19 16	155 43	VK		Felt in district to NW
67	Nov. 13	19 50?	155 40?	W		Felt at Waikii
68	Nov. 25	20 15?	155 50?	VW		Felt in Kohala
69	Nov. 25	19 22	155 26	VHK		Not felt
70	Nov. 26	19 12	155 41	VHK		Not felt
71	Nov. 28	19 25	155 16	VUP		In Kilauea crater
72	Nov. 30	19 23	155 17	VUP		Not felt
73	Dec. 1	19 30	155 33	VH		Not felt
74	Dec. 2	19 30	155 35	VHKW	14	Felt
75		19 34	155 37	VW		Not felt
76		19 30.5	155 34.5	VHKW		Not felt
77		19 29	155 37	VKW		Felt
78		19 32	155 32.5	VHKW		Felt
79		19 29.5	155 37	VKW		Not felt
80	Dec. 2	19 23	155 28	VHKW		Not felt
81	Dec. 7	19 12	155 46.5	VKW		Felt near epicenter
82	Dec. 12	19 25	155 20	VPU	7	Not felt
83	Dec. 14	19 30	155 25	VHKW	25	Felt near Kilauea
84	Dec. 20	19 51	155 17	VHW	5	Not felt
85	Dec. 20	19 24.5	155 18	VUP		Not felt
86	Dec. 20	19 45.5	155 14	VHW		Not felt
87	Dec. 27	19 43	155 21	VH		Felt near epicenter
88	Dec. 27	19 44	155 15.5	VH		Felt near epicenter
89	Dec. 27	19 47	155 20	VH		Felt near epicenter
90	Dec. 27	19 36	155 19	VH		Felt near Kilauea
91	Dec. 30	19 26	155 33	VHKW	17	Felt in Hilo
92	Dec. 31	19 11	155 19	VHW		Not felt

Earthquakes have been reported felt by parties on Mauna Loa, usually while in or near the crater or near the rifts. These quakes often give small instrumental records or none at all. It may be inferred that Mauna Loa earthquakes equal if not surpass the numbers recorded from Kilauea.

The Mauna Loa eruption of 1914[7] was preceded, during two months, by earthquakes more than 20 kilometers away from the Observatory. In October 1933 a similar seismic disturbance occurred. There was a notable increase in the earthquakes in the range of 20 to 100 kilometers. This swarm of earthquakes preceded the outbreak of Mauna Loa by six weeks.

Nearly coincident with the outbreak and probably caused by it, were 13 quakes recorded in slightly more than two hours. Only three of these were felt as far away as Hilo. A party staying at the rest house on the Mauna Loa northeast rift, elevation 10,000 feet, reported that the shocks were quite alarming. Of the 13 shocks, six were large enough and well enough recorded at all stations to be located. The depth of the first was 14 kilometers. The measurements suggest that the following quake (No. 75) was 6 kilometers deep, the next two were near sea level or above, no. 78 was at 4 kilometers depth (possibly above as the elevation of the mountain is 4.2 kilometers), and no. 79 was at 9 kilometers depth. It should be remembered that there were seven smaller unlocatable shocks at this time. One preceded and six followed the six located shocks. It is probable that they were of such high focus as not to record completely at any other station. It is quite likely that they were located in the southeast section of the crater of Mokauweoweo, as the located shocks do not quite coincide with the eruption fissures.

During and after the eruption the known seismic activity migrated away from the volcanic center, the direction being SW, SE, E, and NE. The larger numbers of epicenters were on the NE rift of Mauna Loa and to the east of Mauna Kea.

A list of the recorded earthquakes is given in Table 2 and their location noted on the map (Fig. 1).

[7] H. O. Wood. *The seismic prelude to the 1914 eruption of Mauna Loa.* Bull. Seis. Soc. 5, No. 1. 1915.

GEOPHYSICS.—*A note on the elastic properties of rocks.*[1] ROY W. GORANSON, Geophysical Laboratory, Carnegie Institution of Washington.

Variations in the physical and chemical constitution of rocks are found to produce observable changes in their elastic properties. This fact constitutes an important resource in geophysics because the elastic properties of material at depth in the earth can be evaluated from seismologic data if the density is known. When these elastic properties determined within the earth are compared with the known properties of rocks determined from laboratory measurements important information concerning the nature of the material is at once available. However, in order to make such correlations it is assumed that a simplified form of the elastic theory is valid, that rock specimens are representative of the rock body from which they were removed, that elastic data are independent of the method employed, and that the functional relations are sufficiently well known so that laboratory data can be safely extrapolated beyond the experimental pressure limit. It is well known that these assumptions are not fulfilled exactly, but they approximate to the actual conditions in many cases; in other cases they do not. The addition of new data has reopened the problem of reconciling the elastic properties of rocks calculated from seismic data with those obtained from laboratory measurements.

The elastic symmetry of perfectly annealed, homogeneous glass is isotropic, but that of crystals is not isotropic (anisotropic) and varies with the crystalline symmetry. An aggregate of randomly oriented crystalline grains, such as is present in some rocks, should behave isotropically as a whole if no other variables entered into the scheme of things, but an analysis of the experimental results shows that, under certain conditions, to ignore such other variables would lead to serious error because directional variations apart from mere crystallinity have been observed in the same specimen. Even though we assume that the stress-strain relations are calculable by the classical theory of elasticity the mechanics and contributions of such variables are not sufficiently known at present to be evaluated, and so for purposes of calculation in correlating different data, isotropy is generally assumed as an approximation. If such calculations lead to results consistent with other data general experience is that they will be fairly trustworthy, if not, then these variables cannot be neglected.

[1] Received July 24, 1934.

If homogeneity of constitution and isotropy be assumed there are simple functional relations[2a] between the compressibility β or bulk modulus K ($K=1/\beta$), modulus of rigidity R, Young's modulus E, Poisson's ratio σ, the velocity of the distortional wave V_s ($V_s^2=R/\rho$) and the velocity of the compressional wave V_p ($V_p^2-4V_s^2/3=K/\rho$). These relations are such that if the density ρ, and any two of the quantities are known the others can be evaluated.

The actual determination of elastic properties of rocks can be divided into two types, namely, dynamic methods involving adiabatic changes of state and static methods involving isothermal changes of state.[2b]

In the first group fall all data of seismic origin and some few laboratory data at low pressure obtained by setting the specimens into vibration. All other laboratory data have been derived by static methods. F. D. Adams and Coker[3] determined E and σ by measuring the longitudinal compression and lateral extension under unidirectional thrust (mean stress of 350 bars). The Watertown Arsenal[4] has made similar measurements on rock materials. Nagaoka[5] determined E and R by measuring bending and twisting of specimens. Zisman[6] determined E and σ under unidirectional thrust (to a mean stress of 55 bars) and β under hydrostatic pressure (to 700 bars) by measuring changes in linear dimensions. Nagaoka's values of E and R would lead to negative compressibilities, an absurdity. Zisman's values of E and σ are not consistent with his compressibilities. Moreover, his determinations of $\delta=(1/l_0)\partial l/\partial p$ (where l denotes length, l_0 being the initial length, and p the pressure) are not in general equal to $\frac{1}{3}\beta$ which would be true for isotropy. At low pressures rocks cannot therefore be treated a priori as if they were homogeneous isotropic substances.

Because rocks can differ widely not only in mineral composition but also in grain size and orientation, grain boundary bonding, and kind and amount of open spaces (pores, cracks, etc.) it does not seem surprising that inconsistencies occur when different methods are used. If the seismic disturbance as registered on a seismograph represents that portion which has lost the least amount of energy in its

[2] Roy W. Goranson. *Thermodynamical relations in multi-component systems.* Carnegie Inst. Washington. Publ. 408. 1930: [a] p. 128; [b] p. 122.

[3] F. D. Adams and E. G. Coker. *An investigation into the elastic constants of rocks more especially with reference to cubic compressibility.* Carnegie Inst. Washington Publ. 46. 1906.

[4] Watertown Arsenal Report, 1894.

[5] H. Nagaoka. Phil. Mag. 50: 53. 1900.

[6] W. A. Zisman. Proc. Nat. Acad. Sci. 19: 653. 1933.

travel, and therefore must have followed paths of high elasticity, there is present here a type of discrimination entirely lacking in static methods. The inhomogeneities stated above could then give widely different results for static and dynamic methods at low pressures which would become ironed out at high pressures.

Rock composition, grain size, type of bonding, and porosity will be functions of the conditions at the time of formation and so may be more or less uniform over a relatively large area. Open spaces other than pores will depend on the later history of the region and can be extremely localized. The act of removing a specimen for test may contribute by introducing stresses sufficient to open up cracks and loosen the rock structure. If seismic disturbances as registered are propagated along paths of high elasticity and therefore in effect ignore the open spaces, as Zisman concludes from his data, the bulk modulus will be dependent only on the kind of mineral grains, their orientation, and bonding. The mineral grains may be intimately interlocked, touching at only a few points, or separated by a bond of cementing material. A close knit interlocking structure of randomly oriented grains should have elastic properties approaching the mean of the constituent mineral grains whereas the largest deviation should be found in rocks of loosely aggregated grains. This is corroborated by general experience.

The idea that stresses accumulate mainly in the neighborhood of surfaces of discontinuity of physical properties might lead one to consider changes in geometric shape arising from complicated non-hydrostatic internal strains in the neighborhood of such grain contacts. If such effects were noticeable they would show up in linear measurements as hysteresis or as *anisotropic* behavior, but in volume measurements only plastic flow with increase in density (permanent set) occurred. Such an effect would be most apparent in highly compressible heterogeneous materials such as granite.

Zisman has determined the compressibilities of several rocks to pressures of 700 bars by measuring linear changes with pressure and calculating the volume changes from them. In some of his experiments he has made independent sets of measurements on three separate pieces from the same specimen but cut at right angles to each other. Even such precautions do not seem to have been sufficient to give a truly representative compressibility because, with the exception of one specimen in which the feldspar/quartz ratio was highest and therefore by this criterion should have been the most incompressible, his compressibilities of uncovered granites average *less* than the com-

pressibilities calculated from the volume average of the component minerals; this seems hardly probable because the latter represent minimum value curves to which the experimentally determined values approach asymptotically at high pressures. His compressibility value for uncovered Vermont marble is *less* than the compressibility of calcite and in line with his results on granite. He has also made measurements on a rock which he calls dolomite but describes as having 98 per cent calcite; it may have been incorrectly described but if not it should have a compressibility equal to or more than calcite, his actual value of β is about 14 per cent less than that of calcite.

It might be concluded from such results that a very low form of elastic symmetry is present in such rocks and that when they are strained there is involved not only a change in linear dimensions but also a change in angular dimensions. For example, a cube of granite would not remain a cube or even a rectangular parallelopiped, but deform into some non-rectangular configuration. A measure of the compressibility could not then be obtained, in general, from three linear changes at right angles to each other. From Zisman's results, the change in configuration of such rocks should differ enough quantitatively from a simple contraction of the linear elements to be readily apparent. This low form of symmetry, if it exists, must be confined largely to low pressures, at moderate to high pressures there is fair agreement between linear and volume measurements, and between laboratory and seismic data.

There are, however, other effects at low pressures which must first be taken into consideration. Hysteresis, which implies irreversibility in the sequence of states through which the specimen passes is indicated by *elastic afterworking* and *permanent set* in the results of the Watertown Arsenal, Adams and Coker, and Zisman. *Elastic afterworking* is a term used when the strain produced in a specimen under load is not in general independent of time and when the extent of elastic recovery depends on the length of time a strained specimen is free from load. The results of Adams and Coker and of the Watertown Arsenal show clearly that there is an increase in resistance of rock to deformation from repeated loading and unloading of forces. *Permanent set*, generally grouped under plastic effects, is the term used for ultimate deformation, the specimen never returning to its original condition. These all indicate that the instantaneous state of a rock depends not only on the external conditions prevailing at the instant but also on the previous states. The classical theory of elasticity is, moreover, restricted to conditions in which the strain result-

ing from a load disappears on removal of the load, and this necessary condition is violated by the above hysteresis phenomena.

A rock specimen is probably not in the same state of strain as the parent rock body from which it was obtained. The mere separation of the specimen from the parent body can alter its state of strain by a rearrangement and release of accumulated stresses. Some disturbance, generally by impact, also follows from the removal, and strains induced by a force suddenly applied may be twice those induced by the same force applied slowly. These stresses may be sufficient to further complicate the history of the specimen by opening cracks and loosening the rock structure. The strain history of the rock body will not be known because the conditions existing at the time of its formation will not be those of today, and during the intervening time loading and unloading, aided by shearing forces, will have acted to modify the original stress-strain relations. It can generally be assumed, however, that the rock body will be in a *state of ease* for a higher state of strain than the specimen (that is, it can be strained without permanent set to a higher limit of strain). In this connection it is interesting to note that experimental results obtained at high pressure do not exhibit any of these irreversible phenomena. Bridgman observes a linear hysteresis but this is a true elastic hysteresis in which the stress-strain diagram is a closed, reproducible curve.

It is suggested that if the specimen be first seasoned, perhaps repeatedly, at rather high hydrostatic pressure, the experimental results obtained at low pressure would become more reproducible, more amenable to theoretical treatment and probably more representative of the rock body. For this seasoning the specimen should be made impervious to the pressure fluid in order that the pressure may act on the specimen as a whole.

In the high-pressure range Bridgman[7] has determined $\delta = (1/l_0)\partial l/\partial p$ from linear measurements and L. H. Adams[8] and his co-workers $\beta = (1/V_0)\partial V/\partial p$ by obtaining volume changes from piston displacements. It is indicated that at high pressures rocks become more amenable to treatment as isotropic bodies since the compressibility values of Bridgman and of Adams are generally in good agreement.

However, even for high-pressure data a postulation of isotropy can lead to serious error. It has been stated in this article that perfectly annealed homogeneous glass is isotropic but this is not true for strained glass. In order to obtain basalt glass or tachylite it is

[7] P. W. BRIDGMAN. Am. J. Sci. 7: 81. 1924 (rocks); ibid. 10: 359. 1925 (tachylite).
[8] L. H. ADAMS and E. D. WILLIAMSON. J. Franklin Inst. 195: 475. 1923. L. H. ADAMS and R. E. GIBSON. Proc. Nat. Acad. Sci. 12: 275. 1926 (tachylite).

necessary to cool the melt rapidly because it crystallizes readily. Rapid cooling means steep temperature gradients and this treatment yields a strained glass. Bridgman[7] has determined δ and Adams and Gibson[8] have determined β of Kilauea tachylite in the pressure range of 2 to 12 kilobars. Adams and Gibson's mean value of β at 25°C for this pressure range is 1.45×10^{-6} reciprocal bars. Also, from their residuals, it is apparent that over this range of pressures $\Delta\beta$ is negative and not more than 3 per cent of this value. Bridgman's value of δ at 30°C is 0.45×10^{-6} reciprocal bars to 7350 bars, at pressures above 7350 bars the slope is about the same but *negative*, i.e., the specimen elongates under pressure. On the assumption of isotropy β would be 1.35×10^{-6} reciprocal bars to 7350 bars and then become negative by about the same amount, which of course cannot be true. The reversal point is affected by temperature, which is what we should expect if temperature strains were involved; at 75° there is no reversal, and he finds $\partial\beta/\partial p$, assuming $\Delta\beta = 3\Delta\delta$, negative and about 14 per cent of the compressibility at 7 kilobars for the pressure range of 2 to 12 kilobars. But isotropy cannot be assumed here and β is not equal to three times the change of one linear dimension with pressure at any pressure. A representative β from linear dimensions can only be obtained from the measurements along each of the three principal directions of the strained glass. It would seem reasonable then to assume that β and $\partial\beta/\partial p$ obtained from volume measurements, such as those of Adams and Gibson, will be more reliable than from measurements on one linear dimension of such non-isotropic material, and although it is possible that β might decrease more rapidly at higher pressures, there is no a priori reason for such a conclusion. The extrapolations Daly[9] makes of Bridgman's data at 75° could therefore be in error.

Rock specimens sealed so that they do not come in contact with the compression fluid have a much higher compressibility at low pressures than specimens open to and therefore penetrable by the pressure fluid as is indicated by Zisman's measurements. This would be expected because a certain penetration of fluid into the open spaces of the "uncovered" rock specimens would occur and so prevent these cavities from closing under pressure. In sealed specimens the paths of least resistance are the openings in the rock specimen, the first effect of pressure will be to close up these openings and therefore they will contribute less and less to the compressibility of the speci-

[9] R. A. DALY. *Igneous rocks and the depths of the earth.* (McGraw-Hill Book Co., New York, N. Y.) 1933, pp. 189–190.

men as pressure is increased, consequently the measurements at high pressure of sealed and unsealed specimens would approach one another in value, which is what L. H. Adams and Williamson found to be the case. However, anomalous behavior can occur in uncovered rock specimens because, for a certain pressure fluid, a certain range of differential pressures will be needed to fill the rock cavities with the fluid. These differential pressures may be inappreciable or may be so high that the openings are closed by pressure before they can be filled with the fluid. The effect from openings which lie between these two extremes might result in a compressibility which is high for increasing pressure and low for decreasing pressure. Bridgman concluded that some of the reverse hysteresis he observed in his measurements on changes of length in rock with pressure might be due to this effect.

By way of summation, it would seem from an analysis of the results that a linear method which demands much more in the way of homogeneity and perfection of elastic properties than does a volume method is not as well adapted as the latter method for such heterogeneous materials as rocks, particularly at low pressures.

Secondly, low-pressure experimental results will not be reproducible or strictly applicable to treatment by the classical theory of elasticity unless the irreversible phenomena of plasticity (permanent set) and elastic afterworking be eliminated. Again, a rock specimen will not be representative of its parent rock body because the state of strain is a function not only of the external conditions prevailing at the time but also of the past strain history or conditions. A remedy for both might be obtained by giving the *sealed* specimen a preliminary seasoning at a high hydrostatic pressure, perhaps of the order of ten or twelve kilobars.

Thirdly, rock structure plays an important rôle in low-pressure compressibility but becomes less important as pressure is increased; at 12 kilobars the rock compressibility does not differ very markedly from the volume average of the mineral compressibilities. The slope, $\partial\beta/\partial p$, to 12 kilobars includes then practically the major effect of the rock structure. Compressibilities obtained by extrapolating experimentally determined slopes of crystalline rocks to much higher pressures will therefore be too low. A more representative slope, $\partial\beta/\partial$p, for high-pressure extrapolation will be the average $\partial\beta/\partial$p of the component minerals (averaged by volume percentages).

Fourthly, Zisman found that low-pressure elastic moduli resulting from dynamic methods are higher than those from static methods.

An explanation of this discrepancy, namely, that there is a discrimination by the former resulting in data that in effect ignore the presence of cracks and cavities in rocks, seems reasonable. The first impulse, for example, of a compressional train of waves recorded on a seismograph will be the strongest because it will have lost the least amount of energy. Since this is taken as the travel time of the compressional wave there is introduced a kind of discrimination which is *observational* in character. Elastic moduli obtained from such data will rep-

TABLE 1.—COMPRESSIBILITY OF GRANITE IN RECIPROCAL BARS.

	Pressure in bars			
	1	700	2000	10,000
Mean, calculated from F. D. Adams and Coker's measurements (mean stress 350 bars)	3.30			
Zisman, covered				
Quincy	8.32	2.41		
Rockport	9.17	2.66		
Zisman, uncovered				
Quincy	2.17	1.84		
Rockport	1.95	1.73		
Calculated from mine rals	2.03	2.01	1.98	1.77
L. H. Adams and Williamson (average of three)				
Covered	(2.15)	(2.13)	2.08	1.79
Uncovered	(2.23)	(2.20)	2.14	1.79
Calculated from Leet and Ewing's seismic measurements	2.28			

resent paths of high elasticity in rocks, that is, paths which include a minimum of open spaces. In order to duplicate seismic data, then, the effect of such cracks and cavities must be eliminated from static measurements. For closely bonded mineral grains such as are found among igneous rocks an extrapolation from high-pressure experimental data should agree with low-pressure seismic data. Such a comparison is made in the following table and diagram using granite as the example because the data for it are rather complete, and furthermore the salic rocks as exemplified by granite yield more typical results than do the femic rocks. They are probably also of more interest geologically in the low-pressure field of experimentation.

From the table and diagram it is seen that the best agreement with the near-surface compressibility calculated from the seismic data of

Leet and Ewing[10] is the value obtained (in parentheses) by direct extrapolation downwards of Adams and Williamson's high-pressure measurements.

The femic rocks are more unstable than the salic rocks when exposed to weathering, and this weathering by loosening the rock structure and by alteration of the original minerals can have a large effect

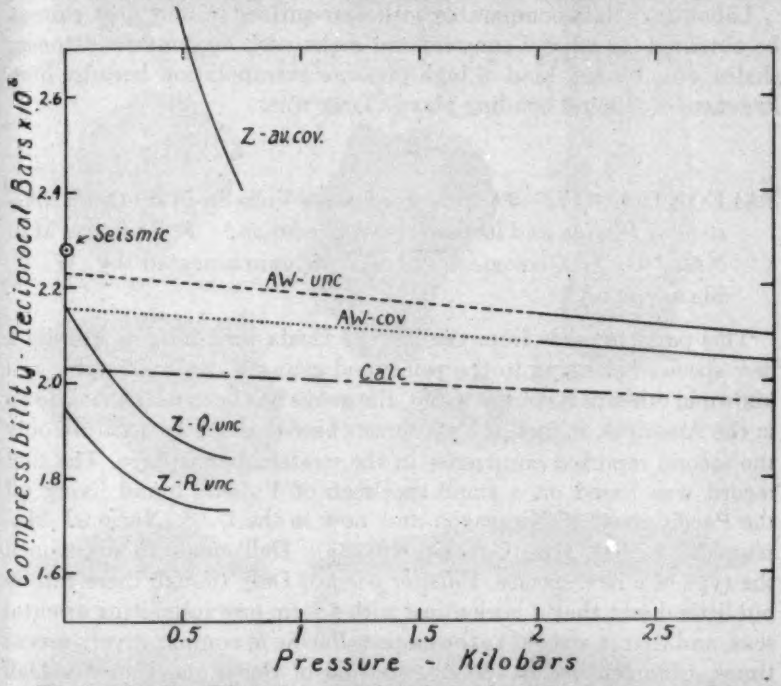

Fig. 1.—Compressibility of granite plotted as a function of pressure; compressibility β in reciprocal bars $\times 10^6$, pressure in kilobars (1 kilobar $= 10^9$ dynes cm^{-2}). *Z-av. cov* refers to average of Zisman's results on covered granites; *Seismic* refers to Leet and Ewing's seismic results on granite; *AW-unc* and *AW-cov* refer to averages of Adams and Williamson's results on uncovered and covered granites respectively, broken lines are extrapolations downwards from high-pressure results; *Z-Q. unc* and *Z-R. unc* refer to Zisman's results on uncovered Quincy and Rockport granites respectively.

on the compressibility of the rock. Measurements made on various diabases result in compressibilities which vary from 1.2 to 1.8×10^{-6} reciprocal bars at 2 kilobars, the freshest rock having the smallest compressibility. This range of values is very materially reduced at higher pressures (at 10 kilobars it is 1.1 to 1.3×10^{-6}) but indicates

[10] L. D. Leet and W. M. Ewing. Physics. 2: 160. 1932. L. D. Leet. Physics. 4: 375. 1933.

that for low pressures, which mean shallow depths and therefore more or less weathering of the rock, a satisfactory average compressibility cannot be obtained. The seismic compressibility of Sudbury norite, from Leet and Ewing's measurements, is 1.56×10^{-6} which corresponds with a downward extrapolation of the mean of values given above, but this is probably merely a coincidence.

Laboratory data comparable with near-surface seismic data cannot be obtained for loosely consolidated rocks such as some sandstones, shales, etc., by any kind of high-pressure extrapolation because here looseness of mineral bonding plays a large rôle.

PALEONTOLOGY.—*The pelecypod genus* Vulsella *in the Ocala limestone of Florida and its bearing on correlation.*[1] F. STEARNS MAC NEIL, U. S. Geological Survey. (Communicated by W. C. MANSFIELD.)

This paper records from the Eocene Ocala limestone of Florida a new species belonging to the pelecypod genus *Vulsella*. Though well known in other parts of the world, the genus has been nearly unknown in the Americas, in fact, the specimens here described constitute only the second reported occurrence in the western hemisphere. The first record was based on a small specimen of *Vulsella* found living off the Pacific coast of Nicaragua and now in the U. S. National Museum (U. S. Nat. Mus. Cat. No. 101935). Dall[2] made this specimen the type of a new species, *Vulsella pacifica* Dall, though there can be but little doubt that it is identical with a form now inhabiting oriental seas, and that it arrived in the eastern Pacific in comparatively recent times. Commenting on the distribution of the genus *Vulsella*, Dall reported the find as the first known occurrence of the genus in the Americas. His remark may be extended to include the entire family.

The species of *Vulsella* are extremely variable. Of the many Recent forms described as species, probably only three or four are valid. Smith[3] retains four in his revision of the genus, whereas Cox[4] after an examination of a large number of specimens from the Eocene of Somaliland believes that even some genera proposed on the basis of fossils may represent mere individual variations.

[1] Published by permission of the Director of the U. S. Geological Survey. Received April 6, 1934.

[2] DALL, W. H. U. S. Nat. Mus. Proc. 52: no. 2183, p. 403. 1917.

[3] SMITH, E. O. Malacolog. Soc. London Proc. 9: 306. 1910–11.

[4] COX, L. R. Roy. Soc. Edinburgh Trans., pt. 1 (no. 2). 1931.

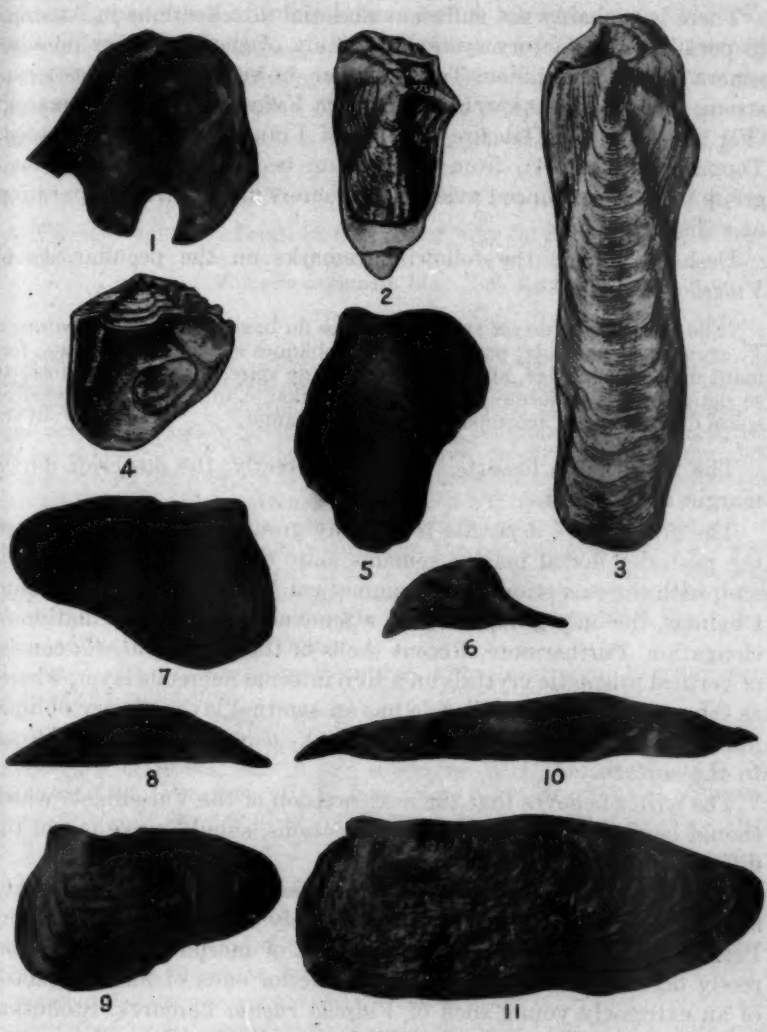

Fig. 1.—*Vulsella deperdita* Lamarck, ×1½. Calcaire grossier. Ully St. George, Oise, France.

Figs. 2–4.—*Vulsella woodi* Teppner, after Wood. Bartonian. Barton, England.

Figs. 5–11.—*Vulsella ocalensis* Mac Neil, n. sp. 5–6.—Juvenile form, ×3. Cotype, 2 miles northeast of Sumpterville, Sumpter County, Fla. 7–9.—Young adult, ×1½. Paratype, 1¼ miles south of Newberry, Alachua County, Fla. 10–11.—Adult, ×1½. Cotype, same locality as Figs. 5–6.

There is probably not sufficient material in collections in America to permit a satisfactory systematic study of the species or possible genera of the Vulsellidae. To the writer, however, the suggestion is strong that the Ocala species forms with *Vulsella deperdita* Lamarck[5] (Fig. 1), from the Calcaire grossier of France, and *Vulsella woodi* Teppner[6] (Figs. 2–4), from the Barton beds of England, a small group whose pronounced aviculid characters may warrant separation as a distinct genus.

Deshayes[7] made the following remarks on the peculiarities of *Vulsella deperdita:*

"Elle se distingue de ses trois congénères du bassin de Paris [*V. minima, V. angusta, V. anomala*] par ses crochets obliques et même divergents, formant dans le jeune âge, un commencement de spire. Le bord de la fossette se détache sous le forme d'une crête tranchante qui suite le movement spiral du crochet et l'accompagne jusqu'au summet."

The "bord de la fossette" is, more correctly, the posterior dorsal margin of the shell.

The group of *V. deperdita* is the only group of vulsellids in which the posterior dorsal margin remains alate or sub-alate in the adult and, with the exception of the enigmatical *Naiadina herberti* Munier-Chalmas, the only group showing a tendency to anterior inflation or elongation. Furthermore, Recent shells of the genus *Vulsella* consist of vertical prismatic crystals on a thin internal nacreous layer, whereas the new species from Florida has an external layer of very oblique fibro-lamellar elements. The prisms of *V. deperdita* are also oblique to the surface.

The writer believes that the next revision of the Vulsellidae, which should be made from Old World collections, should make use of the differences here pointed out.

Curiously enough, confusion has run riot in the orientation of the shells of the Vulsellidae. We are certainly at a loss to know why Bernard[8] disregarded his own principles of morphology and incorrectly designated the anterior and posterior ends of his fine sketch of an extremely young shell of *Vulsella rugosa* Lamarck. Stoliczka[9] ran aground on the assumption of a byssus. Vaillant[10] readily saw the true axial relations upon the dissection of living specimens of *V.*

[5] DESHAYES, G. P. *Animaux sans vertèbres dans le Bassin de Paris.* Texte II, p. 51. 1864.
[6] TEPPNER, W. Centralbl. Mineralogie, Geologie, Paläontologie, 16: 501. 1914.
[7] DESHAYES, G. P. Op. cit. p. 51.
[8] BERNARD, F. Annales sci. nat., Zoologie. 8th ser., 8: 124, *pl. 8, figs. 6, 7.* 1898.
[9] STOLICZKA, F. Palaeontologia Indica, p. 396. 1871.
[10] VAILLANT, L. Annales sci. nat., Zoologie, 5th ser., 9: 284. 1868.

rugosa Lamarck, and Fischer follows him in his *Manuel de Conchyliologie*. Munier-Chalmas[11] and Douville[12] seem to be in correct accord over Recent forms and fossils most nearly related to them, but the anterior marginal inflation of *Vulsella deperdita* Lamarck they confused with the posterior marginal notch of certain Recent and fossil forms.

The new species offered in this paper may be described as follows:

Vulsella ocalensis Mac Neil, n.sp.

Figures 5–11

Shell sub-ostreiform, anteriorly inflated and elongate, thin except at umbo, where it is thickened or camerate; exterior shell layer composed of oblique fibro-lamellar elements, inner layer laminar and compact, probably nacreous, but possibly laminar calcitic; adult sculpture roughly concentric; umbo sub-spiral and opisthogyrate; posterior dorsal margin sharply alate and following the rotation of the beak; ligament area depressed, acute and posteriorly directed in extremely young shell but becoming wider and more anterior in adult; ligament area containing a single deep ligament pit, at first directed posteriorly along the hinge line but swinging anteriorly with the widening of the ligament area; muscle scar just anterior to the beak and close to the ventral margin; anterior ventral corner of ligament area forming a toothlike projection on the otherwise edentulous hinge line.

All of the types are right valves.

Dimensions of larger cotype: length 48 milimeters, height 19 millimeters, convexity 7 millimeters.

Type localities: Cotypes (U. S. Nat. Mus. Cat. No. 373052), Sumpter Rock Co. quarry, about 2 miles northeast of Sumpterville, Sumpter County, Fla. (U. S. G. S. Sta. No. 12751); collectors: W. C. Mansfield and G. M. Ponton, 1932. Paratype (U. S. Nat. Mus. Cat. No. 373053), Cummer Lumber Co., 1¼ miles south of Newberry, Alachua County, Fla. (U. S. G. S. Sta. No. 6812); collector: C. W. Cooke, 1913.

The point of greatest interest in the new Ocala species is the fact that it provides what is probably as good a criterion as any now known for trans-Atlantic correlation. *Vulsella woodi* from the Bartonian and *Vulsella ocalensis* from the Ocala limestone, both rare but intimately related species with a limited geologic range, are not clearly related to any other species of *Vulsella* except their probable prototype, *Vulsella deperdita* from the Calcaire grossier.

A very striking series is seen as we pass from the ventrally elongate, subalate *Vulsella deperdita* through the intermediate *Vulsella woodi* to the anteriorly elongate, conspicuously eared *Vulsella ocalensis*.

[11] MUNIER-CHALMAS, M. Linnean Soc. Normandie Bull. 8: 100. 1863.
[12] DOUVILLÉ, H. *Étude sur les Vulsellidés*. Annal paléontologie. 2: 1907.

BOTANY.—*New Asteraceae from Guatemala collected by A. F. Skutch.*[1]

S. F. BLAKE, Bureau of Plant Industry.

This paper contains descriptions of the new Asteraceae (except the tribe Eupatorieae and the genus *Senecio*) contained in a collection amounting to about 650 numbers made by the ornithologist, Dr. Alexander F. Skutch, in the mountains north of Tecpam (Tecpán), Department of Chimaltenango, Guatemala, in 1933. From the southern base of the mountains, at about 2135 meters elevation (7000 ft.), to about 2745 meters (9000 ft.) the woods are made up mainly of oak, alder, and pine; above 9000 ft. the virgin forests are nearly pure cypress (*Cupressus benthami* Endl.), with a slight admixture of pine and dicotyledonous trees, but no oaks. Lumbering operations above the 9000 ft. level have been followed in some cases by the growth of secondary forest composed of mixed dicotyledonous trees; other areas have grown up again to nearly pure stands of cypress. Below the 9000 ft. level the sporadic but extensive and wasteful native cultivation has left much cleared land and bushy pastures; the most conspicuously abundant composite in such areas throughout the region, but particularly below the 9000 ft. level, is *Baccharis vaccinioides* H. B. K., which sometimes reaches a height of about 10 meters. The two principal localities at which collections were made by Dr. Skutch, Chichavac and Santa Elena, are haciendas in the mountains north of Tecpam, the former three miles from the town and at about 2440–2745 meters altitude, the latter six miles north and at about 2745–3050 meters elevation.

Archibaccharis prorepens Blake, sp. nov.

Herba erecta ca. 5 dm. alta, rhizomate repente; caulis tenuis striato-angulatus pilosulus pilis crispatis multilocularibus; folia oblongo-elliptica v. lanceolata ca. 4 cm. longa acuta basi cuneata argute serrata triplinervia breviter petiolata utrinque in nervis et venis sparse crispo-pilosula; capitula staminea pauca cymosa mediocria ca. 5 mm. alta.

Rhizome slender, about 1.5 mm. thick, 30 cm. long and more; stem about 54 cm. high, 1.5 mm. thick, straight or essentially so, simple below the inflorescence, green, sharply several-striate, not densely pilosulous, especially above, with brownish hairs; leaves alternate; internodes 0.6–2 cm. long; petioles about 2 mm. long, pubescent like the stem; blades 2.5–4 cm. long, 9–12 mm. wide, merely acute, sharply serrate above the entire or subentire lower third or quarter (teeth slender, acuminate, antrorse, 0.5–1.5 mm. long), above deep green, sparsely brownish-pilosulous on the chief nerves and veins (these impressed), beneath paler green, sparsely brown-pilosulous on nerves, veins, and veinlets, definitely but not strongly triplinerved and prominulous-reticulate beneath; some of the upper leaves with short leafy

[1] Received June 25, 1934.

branchlets in their axils; heads 8, cymosely arranged, the pedicels slender, angulate, finely crisped-pilosulous, 8–15 mm. long, naked or with a minute bract; heads subcampanulate, 5–6 mm. high and thick, 15-flowered; involucre about 3-seriate, graduate, 4.5–5 mm. high, the phyllaries linear or linear-oblong, acute or subacuminate, loosely and not densely rather long-ciliate especially toward apex, with green 1-ribbed center and narrower subscarious whitish margins, often purple toward apex; flowers in the head all staminate; ovaries abortive; corollas whitish, about 4.8 mm. long (tube sparsely puberulous with clavellate hairs, 2–2.2 mm. long, throat campanulate, nearly glabrous, 0.8–1 mm. long, teeth triangular, sparsely puberulous, spreading, 1.5–1.8 mm. long); style branches slender, subulate-tipped, hispidulous, 1 mm. long.

GUATEMALA: Clearing in the forest, Santa Elena, Dept. Chimaltenango, alt. 2400–2700 m., 22 Jan. 1933, *A. F. Skutch* 190 (type no. 1,494,847, U. S. Nat. Herb.).

Archibaccharis prorepens is related to *A. simplex* Blake, of Hidalgo, in which the stem is sparsely incurved-hispidulous and the leaves larger (3.5–7 cm. long, 1.3–2.2 cm. wide), feather-veined, and cuneate-oblanceolate to elliptic-obovate.

Archibaccharis hirtella var. **taeniotricha** Blake, var. nov.

Rami eglandulosi dense et sordide patenti-pilosi pilis articulatis.

OAXACA: Climbing over shrubs to 15 ft. in oak woods, Sierra de Clavellinas, alt. 2745 m., 18 Oct. 1894, *Pringle* 4988; Sierra de Clavellinas, alt. 2745 m., 16–19 Oct. 1894, *C. L. Smith* 259. GUATEMALA: Woody vine, scrambling over other vegetation in the cypress forest, sometimes epiphytic and rooted on moss-covered trunks, Santa Elena, Dept. Chimaltenango, alt. 2400–2700 m., 24 Feb. 1933, *A.F. Skutch* 276 (type no. 1,494,938, U. S. Nat. Herb.) (pistillate); woody vine, cypress woods, Santa Elena, alt. about 2900 m., 24 Dec. 1933, *Skutch* 769 (staminate).

Dr. Skutch's two collections of this plant differ so much in pubescence from most of the material of *A. hirtella* (DC.) Heering available that I have been led to make a reexamination of all the specimens of this species in the U. S. National Herbarium. It proves to be divisible into three forms, two of which are very distinct, the third less so. In 1925 I examined in the Prodromus Herbarium the type of *Baccharis hirtella* DC., collected by Haenke at some unknown locality in Mexico on his journeys between Acapulco and the City of Mexico, and noted that it was very closely matched by *Pringle* 11483, from mountains above Eslaba in the Federal District. In this form the branches and inflorescences are densely puberulous with short spreading hairs, nearly all of which are gland-tipped; longer eglandular hairs are wanting or very few. The midrib of the leaves beneath is similarly glandular-pubescent or sometimes pilose with eglandular hairs. The following specimens in the U. S. National Herbarium are referable to this typical form:

STATE OF MEXICO: *Bourgeau* 955 in part; *Purpus* 18, 1499. FEDERAL DISTRICT: *Pringle* 11483. MORELOS: *Juzepczuk* 820. GUERRERO: *E. W. Nelson* 2237, 2238. OAXACA: *Nelson* 2336 (by error listed as 2236 in my paper

Fig. 1.—*Adenocaulon lyratum* Blake.—*a*, plant, ×¼; *b*, flowering head, ×3; *c*, submature achene, ×2½; *d*, pistillate flower, ×4; *e*, style of pistillate flower, ×15; *f*, hermaphrodite flower, ×6; *g*, style of hermaphrodite flower, ×10; *h*, two stamens, ×15.

on Hemibaccharis in 1924). MEXICO without definite locality: *Ehrenberg* 1408.

The other extreme form of the species, with the branches and inflorescences, as well as the midrib of the leaves beneath, densely spreading-pilose with many-celled brownish hairs and essentially eglandular, has been described above. The third form, less distinct than the two others, is

Archibaccharis hirtella var. **intermedia** Blake, var. nov.

Rami eglandulosi puberuli vel breviter pilosuli pilis articulatis antrorse curvatis v. incurvis interdum subpatentibus.

TEPIC: Without definite locality, Jan.–Feb. 1892, *Palmer* 1846. VERACRUZ: Shaded banks near Orizaba, alt. 1280 m., 25 Jan. 1895, *Pringle* 6108 (type no. 252873, U. S. Nat. Herb.). MORELOS: Mountain canyons above Cuernavaca, alt. 1980 m., 11 Nov. 1902, *Pringle* 9853. OAXACA: Valley of Oaxaca, alt. 1675–2285 m., 20 Sept. 1894, *Nelson* 1471.

Adenocaulon lyratum Blake, sp. nov.

Caulescens parce erecto-ramosum; caulis anguste alatus eglandulosus; folia lyrato-pinnatifida; achenia cuneato-obovoidea compressa apice late rotundata; antherae apice vix appendiculatae.

Erect perennial herb, about 75 cm. high, the very short rootstock bearing a cluster of fleshy fibrous roots; subterranean portion of stem about 5 cm. long, bearing a few small scales; stem slender, sparsely erect-branched, thinly arachnoid-tomentose, glabrescent or glabrate, narrowly winged throughout except in branches of inflorescence by the decurrent leaf-bases (wings arachnoid-tomentose on one side, 2 mm. wide or less); principal leaves 6–8, crowded near base of stem, lyrate-pinnatifid, obovate in outline, 20–27 cm. long, 6–10.5 cm. wide, above thinly arachnoid, quickly green and glabrate except for short subglandular hairs along the veins, beneath thinly and persistently canescent-arachnoid-tomentose, feather-veined, the terminal lobe pentagonal-deltoid, slightly cordate, acute or obtusish, shallowly repand and minutely mucronulate on margin, the lateral lobes 2–4 pairs, decreasing in size toward base of leaf, broadly oblong to obovate or suborbicular, acute to very obtuse, spreading or retrorse, the broadly margined petioliform base of leaf entire, 3–9 cm. long; leaves above base of stem few (about 3–4), the lower similar to the basal but smaller and with shorter more broadly margined petioliform base, the upper with only 1–2 pairs of lobes; inflorescence branches thinly arachnoid, glabrescent, eglandular, with minute subulate bracts, the heads solitary or paired in the axils, their peduncles erect, at first thickly arachnoid-tomentose, becoming 4 cm. long; heads 10–16-flowered, in flower 2–3 mm. thick; phyllaries subuniseriate, 6–8, subequal, ovate, acute, 1.5–2 mm. long, 0.8–1.2 mm. wide, thin-herbaceous, thinly arachnoid outside, reflexed in age; pistillate flowers 5–8, their corollas white, 0.7–1 mm. long (tube 0.2–0.3 mm. long, teeth 4–5, recurved-spreading, ovate-oblong, acutish, 0.5–0.7 mm. long); hermaphrodite flowers 5–8, the ovary abortive, glabrous, 1.2 mm. long, the corolla white, about 2.2 mm. long (tube cylindric, 0.8 mm., throat funnelform, 0.3–0.4 mm., teeth 5, oblong-ovate acutish, papillose outside at the slightly thickened apex, 0.8–1 mm. long; achenes (not mature) cuneate-obovoid, compressed, green, about 3-nerved on each side, stipitate-glandular, 5.5 mm. long, 3 mm. wide.

GUATEMALA: In open oak woods, Chichavac, Dept. Chimaltenango, alt. 2530 m. (8300 ft.), 20 Sept. 1933, *A. F. Skutch* 622 (type no. 1,587,623, U. S. Nat. Herb.).

This plant is a most distinct and unexpected addition to one of the most distinctive genera of the family Asteraceae. Only five[2] nominal species of the genus have hitherto been recognized from the western United States and Canada, eastern Asia, and southwestern South America. In the best known species, *Adenocaulon bicolor* Hook., ranging from British Columbia to south-central California, eastward to Montana and sparingly to Michigan, the stem is stipitate-glandular, especially above, and the leaf blades are deltoid or ovate-deltoid, from subentire to shallowly sinuate-toothed or -lobed, usually hastate at base, and borne on a narrowly winged petiole usually much longer than the blade. The leaves are chiefly basal or subbasal, although sometimes extending half way up the stem. Two species have been described from eastern Asia, *A. himalaicum* Edgew. of the Himalayan region, at about 1830–3660 meters elevation (6–12000 ft.), and *A. adhaerescens* Maxim. of Japan. The two are generally considered identical, and are so closely allied to *A. bicolor* that they have been combined with it as a variety (var. *adhaerescens* (Maxim.) Makino) or even united outright, as by Hooker in the *Flora of British India*. The material at hand, although insufficient to settle the status of the Asiatic forms, indicates that the plant of China and Japan is specifically distinct from *A. bicolor*. Two species have been described from southern Chile and the Magellan region, *A. chilense* Poepp.[3] and *A. lechleri* Sch. Bip. The material available is again too slight to enable me to form an opinion as to the distinctness of the supposed species. Reiche, who combines them under the name *A. chilense*, assigns the species a range "en los montes claros de *Nothofagus pumilio*" from the cordilleras of Nahuelbuta and Chillan to the Strait of Magellan. In this plant the stem and inflorescence are purple-glandular, and the leaves oblong or elliptic-oblong, faintly crenate-denticulate, cuneate-rounded to subcordate at base, and narrowly decurrent on the upper part of the petiole, which is about equal to or much shorter than the blade. The Guatemalan *A. lyratum*, constituting the third distinct group in this obviously relict genus, is readily distinguished by its lyrate-pinnatifid leaves, its leafy, winged, eglandular stem, and its comparatively broad, cuneate-obovoid achenes.

The floral details of the species of *Adenocaulon* have not been sufficiently noticed. Bentham and Hooker, in the *Genera Plantarum*, described the corollas as all regular and tubular, and the anthers as entire or barely minutely 2-dentate at base. They placed the genus in the Helianthoideae-Millerieae.

[2] Not counting *Adenocaulon integrifolium* Nutt., universally regarded as identical with *A. bicolor*.

[3] This species is universally attributed to Lessing, but was published by him as of Poeppig. An interesting commentary on the un-Composite-like appearance of the plants of this genus is furnished by the synonym *Boerhaavia nudicaulis* Phil., cited by Reiche under *A. chilense*.

Gray,[4] in his notes on Bentham's work, called attention to the fact that the anthers are strongly sagittate at base, and referred the genus to the Inulese as a separate subtribe, the Adenocauloneae. Some years later[5] he stated, after examining all the species, that "the basal auricles of the sagittate anthers are manifestly produced into a slender acumination or small tail, the adjacent ones connate," and suggested that *Carpesium* might be associated with *Adenocaulon* in this subtribe, the name of which he emended to Adenocauleae. In the *Synoptical Flora*[6] he described the anthers as "minutely but evidently caudate, connate," and noted that the corollas of the pistillate flowers are bilabiate in the Chilean species, with the outer lip 3-lobed; those of the Californian species he regarded as regularly 4-lobed.

Adenocaulon chilense is, in its floral details, the most highly developed species of the genus. The corollas of the pistillate flowers are, as described by Gray, bilabiate. The outer lip is oval, at first erectish and somewhat boatshaped, later recurving, and is merely 3-dentate or 3-denticulate; the inner is sometimes entire and apparently made up of a single linear lobe, sometimes 2-dentate, sometimes 2-parted to base. The anthers have ovate or triangular-ovate terminal appendages of normal size and at base are deeply sagittate and provided with linear papillose tails, connate as in the other species, the adjoining ones often decidedly unequal. The style branches in the pistillate flower are rather smaller than elsewhere in the genus, and ovate or quadrate, obtuse; the style in the hermaphrodite flowers is slightly clavate and papillose above, and is barely notched or sometimes bifid.

In *Adenocaulon bicolor*, of western North America, the corollas of the pistillate flowers are usually 4-lobed, sometimes 3-lobed, and are either essentially regular, or slightly irregular with somewhat smaller inner lobe. The anthers have conspicuous triangular-ovate or almost subulate terminal appendages and at base are provided with usually inconspicuous tails, these short- or elongate-triangular. The style branches in the pistillate flower are relatively large, quadrate or even subflabellate, and are subtruncate or broadly rounded with somewhat wavy margin; the style in the hermaphrodite flowers is cylindric or slightly clavate, papillose above, and entire.

The material at hand from eastern Asia consists of 10 sheets, all from Japan and China, no material from the Himalayas, the type region of *A. himalaicum* Edgew., being available. In general appearance this plant, *A. adhaerescens* Maxim., is similar to *A. bicolor* of western North America, but the heads are larger and more numerously flowered and the leaves, at least in the Chinese material, are reniform or reniform-orbicular rather than deltoid. Most of the Japanese material, however, has the leaves shaped more as in the North American plant, but with conspicuously winged petioles which are often considerably dilated at the base. Better and more mature material (all these specimens except one being without fruit) might make it

[4] Proc. Amer. Acad. 8: 653. 1873.
[5] Proc. Amer. Acad. 17: 214. 1882.
[6] Syn. Fl. 1[2]: 59. 1884.

possible to distinguish more than one Asiatic form. At any rate, as a group they differ sufficiently in floral details to indicate that they are not specifically identical with the North American plant. The pistillate corollas are usually 5-lobed (rarely 4-lobed) and are distinctly irregular, the 2 inner lobes being shorter than the 3 outer and sometimes united to well above the middle. The style branches in the pistillate flower are smaller than in *A. bicolor*, and more or less quadrate; the style in the hermaphrodite flowers is not distinguishable from that of *A. bicolor*. The principal difference, already indicated by Edgeworth for his *A. himalaicum*, is that the terminal appendages of the anthers are greatly reduced, varying from a short deltoid tip to a mere convexity or a blunt mucro. The basal appendages, also, are less developed than in *A. bicolor*.

In *Adenocaulon lyratum* the pistillate corollas are regularly 4-5-lobed, with spreading lobes. The style branches in the pistillate flowers are broadly oblong and truncate; the style in the hermaphrodite flowers is slightly clavate and minutely indented at the papillose apex. The anthers have short triangular basal tails and are provided at apex with the minutest blunt mucro or are essentially without appendage. Even before the corolla opens, the anthers are already dehiscent and connate only in their lower half.

The corollas of the pistillate flowers in this genus frequently bear abortive anthers.

Calea skutchii Blake, sp. nov.

Frutex v. arbor parva; rami et ramuli dense et sordide sublanatopilosi; folia ovata petiolata serrata acuminata basi cuneata submembranacea triplinervia ca. 1.2 dm. longa supra scaberula subtus in venis et venulis omnibus pilosula in pagina glanduloso-adspersa; capitula parva radiata aurea cymoso-paniculata; involucri ca. 4-seriati ca. 6 mm. alti phyllaria exteriora oblongo-lanceolata interiora oblonga v. cuneato-obovata obtusa apice aureoscariosa pilosula et plusminusve ciliolata; achenia anguste cuneata hirsutula pappo duplo longiora; pappus eum Viguierae simulans, e aristis 2 subpaleaceis et squamellis ca. 6 subduplo brevioribus sistens.

Shrub or small tree, reaching 7.5 m. in height; branches stoutish, terete, striatulate, about 6 mm. thick, densely pilose with brownish many-celled somewhat matted hairs; internodes 3–8 cm. long; leaves opposite; petioles 1.5–3 cm. long, pubescent like the stem; blades of the larger leaves 10–17.5 cm. long, 4.5–6.5 cm. wide, acuminate and somewhat falcate, usually long-cuneate at base, serrate above the entire base (teeth about 15–25 pairs, 2–5 mm. apart, depressed-triangular, mucronulate, the mucro callous, about 0.3 mm. long), tripli-nerved 1–3.5 cm. above the base or sometimes 5-plinerved, somewhat bullate above, prominulous-reticulate beneath, above scabrid with short slightly tuberculate-based antrorse-curved hairs, beneath slightly paler, densely pilosulous on all the veins and veinlets with loosely spreading whitish hairs and along costa spreading-pilose; heads about 1.4 cm. wide, very numerous, forming a ternately divided convex or flattish panicle 18–28 cm. wide, about equaled by the leaves; pedicels slender, densely sordid-pilosulous, mostly 4–10 mm. long; disk slender-campanulate, 9–11 mm. high, 4.5–7 mm. thick (when moistened); involucre not strongly

graduated, the few outermost phyllaries oblong or oblong-ovate or -lanceolate, about 2.5–3.5 mm. long, about 0.7 mm. wide, obtuse or acutish, with subindurate body and short somewhat loose greenish apex, the others narrowly oblong to oblong- or wedge-obovate, obtuse or apiculate, about 2 mm. wide, sometimes purple-dotted or -lineolate above, with subindurate more or less vittate body, narrow yellow subscarious margin, and broad scarious rather loose yellow tip; receptacle convex; rays 8, pistillate, golden yellow, the tube 2 mm. long, stipitate-glandular, the lamina oval, 2–3-denticulate, 6–7-nerved, 5 mm. long, 3 mm. wide; disk flowers about 28–32, their corollas golden yellow, 5 mm. long (tube stipitate-glandular, 1.7 mm., throat slender-campanulate, finely stipitate-glandular, 2.5 mm., teeth ovate, slightly stipitate-glandular, 0.8 mm. long); pales narrow, about 7 mm. long, 1-nerved, pilosulous along keel especially above, puberulous toward apex, the somewhat ampliate, obtuse or apiculate, scarious, golden-yellow or sometimes brownish tip slightly spreading; achenes (immature) narrowly cuneate, compressed-quadrangular, 3.5 mm. long, 0.8 mm. wide, blackish brown, 1-ribbed and usually 2–3-nerved on each side, hirsutulous on the angles and toward apex; pappus awns 2, lanceolate, acuminate, hispidulous-ciliolate, about 1.5 mm. long; squamellae on each side about 2–4, linear to oblong, acute or lacerate, 0.5–0.8 mm. long, one sometimes joined to the awns on each side at base; style branches with short triangular finely hispidulous appendages.

GUATEMALA: Hardwood forest, Chichavac, Dept. Chimaltenango, alt. 2400–2700 m., 27 Feb. 1933, *A. F. Skutch* 294; bushy second growth on mountain side by the "Camino real" above Tecpam, Dept. Chimaltenango, alt. about 2745 m., 4 Dec. 1933, *Skutch* 729 (type no. 1,587,727, U. S. Nat. Herb.).

Although the pappus of this plant is so similar to that of *Viguiera* as to be practically indistinguishable, the fertile rays and scarious-tipped phyllaries show that it is really a *Calea* of the subgenus *Tetrachyron*, deviating somewhat in pappus character from the generally accepted definition of that group. It is quite distinct from any of the half dozen members of that group already described.

Alepidocline Blake, gen. nov.

Herba annua ramosa pubescens et parum glandulosa, foliis oppositis ovatis petiolatis serratis triplinerviis membranaceis, capitulis heterogamis radiatis mediocribus cymosis, radiis parvis albis denique roseis v. purpureis, disco aureo. Involucri ovoidei v. hemispherici gradati ca. 5–6-seriati phyllaria elliptico-oblonga v. ovalia v. intima lanceolato-oblonga viridescentia subsicca vittata obtusa v. intima acuta anguste subscarioso-marginata intima apice purpurascentia. Receptaculum convexum hirsutulum nudum vel interdum prope marginem paleis paucissimis linearibus integris onustum. Radii 1-seriati feminei fertiles, tubo elongato tenui, lamina parva patente 3-dentata. Flores disci numerosi hermaphroditi fertiles, corollis tubulosis, tubo limbo longiore, faucibus campanulatis, dentibus 5 brevibus. Stamina 5, antheris basi obtuse sagittatis, apice appendice oblongo-ovata obtusa munitis. Styli rami lineares ad apicem minute hispiduli, appendice deltoidea obtusa papillosa praediti. Achenia obovoidea obcompressa plano-convexa parva glabra nigra lucida, apice annulo brevissimo subintrorso donata. Pappus caducus e aristis ca. 8–10 1-seriatis seti-

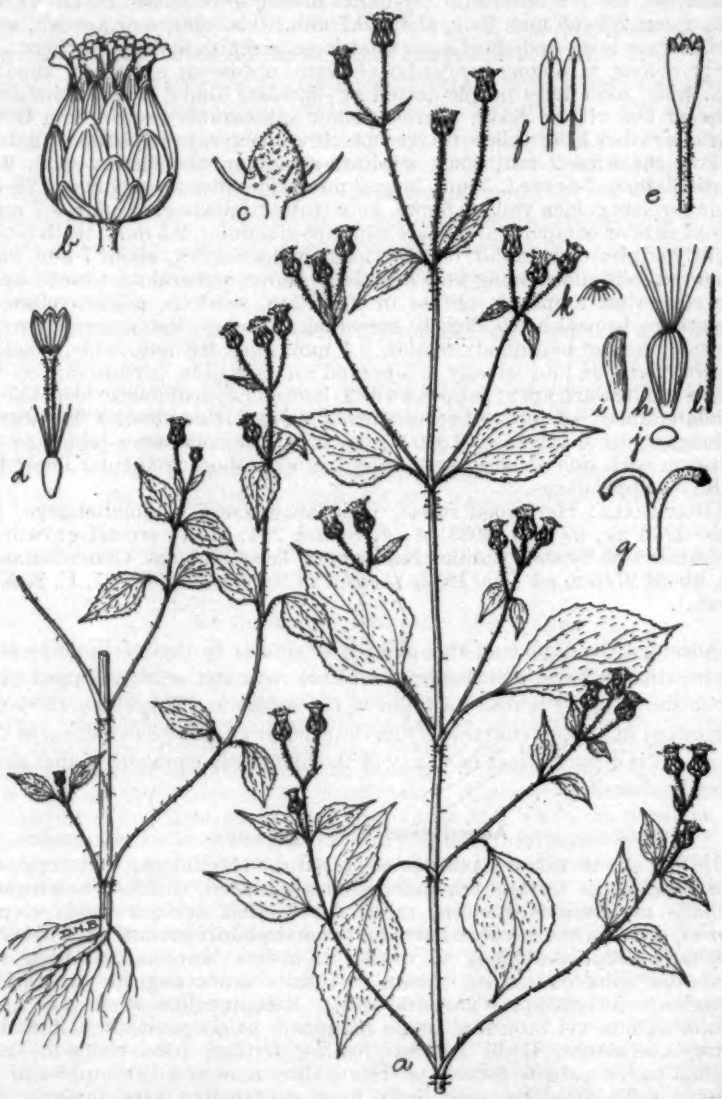

Fig. 2.—*Alepidocline annua* Blake.—*a*, plant, ×½; *b*, head, ×3½; *c*, receptacle, ×5; *d*, ray flower, ×5; *e*, disk corolla, ×8; *f*, two stamens, ×15; *g*, style branches of disk flower, ×15; *h*, disk achene, ventral view, ×8; *i*, same, lateral view; *j*, same in cross section; *k*, apex of achene, enlarged; *l*, pappus awn, ×13.

formibus parum inaequalibus hispidulis sistens.—Species typica *Alepidocline annua*, sp. nov.

Alepidocline annua Blake, sp. nov.

Character ut supra donatus.

Slender erect annual, 6–8 dm. high, with opposite erectish or spreading-ascending branches; stem 2.5–5 mm. thick, terete, striatulate especially above, purplish, sparsely spreading-pilose especially just below the nodes with several-celled, acuminate, white, not tuberculate-based hairs and in the region of the inflorescence with some shorter gland-tipped hairs; internodes 6.5–16 cm. long, petioles slender, flattened, pilose on margin and back, 5–30 mm. long, connate in a line at base; blades 4.5–7.5 cm. long, 2.5–4.5 cm. wide, acuminate and often somewhat falcate, cuneate at base, serrate above the entire or subentire cuneate base (teeth about 9–18 pairs, 2–4 mm. apart, usually depressed-deltoid, with short obtuse callous usually purplish mucros), triplinerved a little above the base and lightly prominulous-reticulate beneath, above rather light green, sparsely and uniformly pilose with few-celled spreading white hairs (the basal cell short, somewhat swollen, and subglandular) and on the veins sparsely pilose with shorter many-celled hairs, beneath scarcely paler green, similarly but somewhat more densely pubescent; heads about 5–8 mm. wide, in small cymes of 2–4 at tips of stem and branches, together forming a loose leafy panicle, the pedicels naked, 1.5–4 cm. long, spreading-pilosulous and with sparse shorter gland-tipped hairs; disk 6–7 mm. high, about 5–6 mm. thick; involucre 5–6.5 mm. high, in the dried state hemispheric, 6–10 mm. thick, when moistened bluntly ovoid (in young flower, then 5 mm. thick) to campanulate-hemispheric (when submature, then 6 mm. thick), the outermost phyllaries elliptic or oblong, about 2.5 mm. long, 1 mm. wide, obtuse, about 3-nerved, slightly ciliolate, the middle ones oval, 2.5–3 mm. wide, 6–7-nerved, the inner oblong-lanceolate, acute or acuminate, obscurely ciliolate, the inner and often the middle with purplish tips, all appressed; rays 10–17, the tube spreading-pilosulous, 3.2–5 mm. long, the lamina quadrate-oblong, white turning pink or purplish with age, 1.5 mm. long, 1 mm. wide, 3-dentate, 5–7-nerved; disk flowers numerous, their corollas yellow, 3–3.5 mm. long (tube spreading-pilosulous, 2–2.2 mm. long, throat slender-campanulate, essentially glabrous, 0.7–1 mm. long, teeth ovate, hispidulous, 0.3–0.4 mm. long); achenes obovoid, 1.5 mm. long, 0.8 mm. wide, black, shining, glabrous, finely and rather obscurely several-striatulate, plano-convex or sublenticular, the outer face rounded, the inner flattish or somewhat rounded, sometimes sulcate or bluntly 1–2-ribbed; pappus awns whitish, 1.5–1.8 mm. long.

GUATEMALA: Weed in cornfield, Chichavac, Dept. Chimaltenango, alt. 2430 m. (8300 ft.), 2 Dec. 1933, *A. F. Skutch* 722 (type no. 1,587,766, U. S. Nat. Herb.).

Although only a cornfield weed, this plant evidently represents a new genus allied to *Schistocarpha*, but differing in its essentially naked receptacle and in its obcompressed achene with rounded summit and slightly introrse apical annulus, much narrower than the achene and bearing a pappus of fewer, slightly stouter, setiform awns. In *Schistocarpha* the receptacle is paleaceous throughout, with a usually trifid pale at the base of each flower, and the achenes are slenderly obovoid-oblong, subterete or slightly 3–5-

angulate, truncate at apex, and bearing a short slightly expanded collar terminating in a disk composed of the united bases of the numerous pappus bristles, from which the fragile bristles themselves are readily deciduous. In its general appearance, *Alepidocline* is suggestive of the tribe Heliantheae. The generic name is derived from α, privative, λεπίς, a scale, and κλίνη, a bed.

Cirsium guatemalense Blake, sp. nov.

Bienne 1.5 m. altum, radice tenui elongato; caulis arachnoideo-lanatus supra pauci-ramosus; folia oblonga v. lanceolato-oblonga sessilia breviter decurrentia acuminata usque ad vel ultra medium pinnatifida supra tenuiter arachnoidea mox glabrescentia v. glabrata non setosa subtus canescenti-tomentosa submembranacea, lobis ca. 11-jugis oblongis sinuato-dentatis v. sinuato-lobatis saepe subbifidis modice spinosa, spinis tenuibus albidis 3–5 mm. longis; capitula ca. 8–10 majuscula ca. 3–4 cm. alta 4–5 cm. crassa ut videtur nutantia saepius solitaria in ramis elongatis foliosis; involucri 2.7–3.5 cm. alti valde et regulariter gradati ca. 8-seriati basi bracteis paucis parvis spinoso-pinnatis donati phyllaria erecta v. appressa anguste triangularia integra sensim acuminata margine infra spinam dense et pulchre canescenti-arachnoideo-tomentosa nigrescenti-viridia anguste et pallide subscarioso-marginata, omnia (intimis innocuis exceptis) spina erecta subvalida albida 3–7 mm. longa donata; corollae albidae, limbo tubo paullo breviore paullum infra medium 5-fido.

Evidently biennial, the rather slender scarcely branched root 14 cm. long and more; stem rather stout, 8–14 mm. thick, striate, erect, hollow, rather thinly brownish-arachnoid-lanate; internodes 2–6 cm. long; principal leaf blades 15–30 cm. long, 5–12 cm. wide, decurrent for 0.5–3 cm. (the wings spiny-lobed), soon bright green above and nearly or quite glabrous except for some sordid pilosity along costa and chief lateral veins, beneath densely canescent-tomentose and along the costa brownish-lanate, the terminal lobe slender, acuminate, 2.5–4.5 cm. long, tipped with a spine about 3 mm. long, the lateral lobes about 2–4 cm. long and about 1.2–3 cm. wide, their teeth and tip bearing rather weak whitish spines 2–4 (–8) mm. long; heads solitary (rarely in 3's) on erectish leafy branches or peduncles 18–30 cm. long, their leaves similar to those of main stem but much smaller (4.5–8 cm. long) and with only about 5–7 pairs of teeth or short lobes, their spines up to 10 mm. long; involucre (in dried state) hemispheric, umbilicate at base, the phyllaries 1.2–2.5 mm. wide below, 1-ribbed at apex, not glandular, the inner purplish toward base of spine, the inmost with very narrow erectish entire purplish subscarious tip; corollas 2.1–2.7 cm. long (tube 12–14 mm., throat distinct, 4–6 mm., teeth linear, acute, slightly thickened subapically, 5–7 mm. long); achenes oblong, blackish with whitish apex, glabrous, shining, 4.5 mm. long; pappus whitish, 2 cm. long, the awns all plumose, about 10 of the inner slightly thickened at apex; anthers light purple, with narrowly triangular, slenderly acuminate tips; node of style obscure.

GUATEMALA: Edge of oak woods, Chichavac, Dept. Chimaltenango, alt. 2530 m. (8300 ft.), 10 Nov. 1933, *A. F. Skutch* 660 (type no. 1,587,661–3, one plant mounted on three sheets).

Cirsium guatemalense finds its nearest ally, apparently, in *C. radians* Benth., also Guatemalan. In that species, however, according to Petrak's description,[7] the phyllaries are more or less dimorphous, the outer longer

[7] Beih. Bot. Centralbl. 27: Abt. 2: 240. 1910.

and subrecurved, with a long spreading spine, the inner erect and not spinose. In *C. guatemalense* the phyllaries (except the inmost) are all similar, erect, and strongly graduated in length from the short outer to the long inner.

BOTANY.—*The American species of* Elytraria.[1] E. C. LEONARD, U. S. National Museum. (Communicated by E. P. KILLIP.)

Elytraria, a genus of Acanthaceae, subfamily Nelsonioideae, was described[2] by Michaux in 1803. He published at this time a single species, *E. virgata*, citing as a synonym *Tubiflora carolinensis* Gmel.[3] Although antedating *Elytraria*, *Tubiflora* is rejected by the International Rules. Since Michaux's publication about 30 species have been described by various authors, though most of these have been reduced to synonymy.

The name *Elytraria* is derived from the Greek ελυτρον (*elytron*, sheath), in reference to the firm coriaceous bracts which sheathe the scapes and subtend the flowers. When herbaceous and having a rosette of basal leaves, fibrous roots, and simple scapes tipped by cylindric spikes, these plants superficially resemble the common plantain (*Plantago*). The flowers are white or blue, and inconspicuous. In *E. tuberosa*, here described as new, the roots are thick-fusiform, resembling those of *Ruellia tuberosa*. In all other species of the genus the roots are fibrous.

The genus, as here regarded, consists of seven species, all native of temperate or tropical America, except *E. acaulis* (L. f.) Lindau, which is found chiefly in Africa. *Elytraria squamosa* (Jacq.) Lindau, widely distributed throughout tropical and subtropical America, is found also in Asia and the Philippine Islands.

KEY TO THE AMERICAN SPECIES

Flower bracts, or at least some of them, tridentate, the lateral teeth scarious, triangular or rhombic, the middle tooth awn-shaped; plant usually caulescent..... 1. E. squamosa.

Flower bracts entire; plant acaulescent.

Scapes 15 to 35 cm. long, much exceeding the leaves.

Leaf blades oblong-elliptic, usually more than 2 cm. wide.

2. E. caroliniensis.

[1] Published by permission of the Secretary of the Smithsonian Institution. Received June 12, 1934.

[2] Fl. Bot. Amer. 1: 9. *pl. 1.* 1803.

[3] J. F. GMELIN, Syst. Nat. 27. 1791.

Leaf blades linear-spatulate, less than 1 cm. wide.
3. E. angustifolia.

Scapes 2 to 8 cm. long, rarely exceeding the leaves.
Leaf blades ovate, rounded or cordate at base, easily distinguishable from the winged petiole.....**4. E. tuberosa.**
Leaf blades oblong-elliptic or spatulate, gradually narrowed into the winged petiole.
Flower bracts acute, 3 to 4 mm. long; leaves densely pilose.
5. E. shaferi.
Flower bracts long-attenuate, 1 cm. long; leaves glabrous or sparingly pilose.....**6. E. bromoides.**

1. **Elytraria squamosa** (Jacq.) Lindau, Anal. Inst. Fisico-Geog., Costa Rica **8**: 299. 1895.

Verbena squamosa Jacq. Pl. Hort. Schoenbr. **1**: 3. *pl. 5*. 1797.
Elytraria tridentata Vahl, Enum. Pl. **1**: 107. 1804.
Elytraria frondosa H. B. K. Nov. Gen. & Sp. **2**: 234. 1817.
Elytraria fasciculata H. B. K. Nov. Gen. & Sp. **2**: 235. 1817.
Elytraria ramosa H. B. K. Nov. Gen. & Sp. **2**: 235. 1817.
Elytraria scorpioides Roem. & Schult. Syst. Veg. Mant. **1**: 128. 1822.
Elytraria apargiifolia Nees in DC. Prodr. **11**: 65. 1847.
Elytraria microstachya Oerst. Nat. For. Kjöbenhavn Vid. Medd. **1854**: 114. 1854.
Elytraria pachystachya Oerst. Nat. For. Kjöbenhavn Vid. Medd. **1854**: 116. 1854.
Tubiflora squamosa Kuntze, Rev. Gen. Pl. **2**: 500. 1891.
Tubiflora pachystachya Kuntze, Rev. Gen. Pl. **2**: 500. 1891.
Elytraria tridentata wrightii Gomez, Anal. Hist. Nat. Madrid **23**: 280. 1894.

The type locality of *Verbena squamosa* is unknown. The other species listed above were all based on specimens from tropical America.

RANGE: Arizona and Texas; Mexico and Central America; West Indies; northern and western South America; India; Philippine Islands.

A widely distributed species, extremely variable in its habit of growth. Although occasionally acaulescent and composed of a single spike-tipped scape arising from a rosette of basal leaves, the plant commonly develops a subligneous stem reaching several decimeters in length. From the tip of the stem there usually branches a cluster of scapes bearing from one to several spikes, or instead of spikes a cluster of leaves and secondary scapes, a proliferous condition, thus resulting. The scapes and stems may be simple, or branched in an irregular fashion. This method of growth often produces plants composed of an intricate mass of scapes and spikes which may be, at maturity, entirely devoid of foliage.

A marked variation is to be found also in the leaf blades. Typically oblong to oblong-obovate and 1 to 2 cm. wide, they become at times narrowly linear. Again, very broad leaves essentially ovate in outline are sometimes produced. The margin may be entire or sinuate-dentate. Other marked

variations in size and shape are to be found in the spikes and flower scales. The scarious lateral teeth of the flower bracts may be conspicuous and well developed, or almost if not entirely obsolete.

Fig. 1.—*Elytraria tuberosa* Leonard, sp. nov. A, plant ×½; B, flower bract ×2; C, calyx ×2.

2. **Elytraria caroliniensis** (Walt.) Pers. Syn. Pl. 1: 23. 1805.

Anonymos caroliniensis Walt. Fl. Carol. 60. 1788.
Tubiflora caroliniensis Gmel. Syst. Nat. 27: 1791.
Elytraria virgata Michx. Fl. Bor. Amer. 1: 9. *fig. 1.* 1803.
Elytraria cupressina Nees in DC. Prodr. 11: 65. 1847.
Elytraria virgata vahliana Nees in DC. Prodr. 11: 65. 1847.
Elytraria virgata latifolia Nees in DC. Prodr. 11: 65. 1847.

TYPE LOCALITY: Carolina.
RANGE: Coastal plain from South Carolina to Florida.

A species well marked by its large basal leaves and stout virgate scape, tipped by one or more spikes. It is a pine-barren plant frequenting damp sandy woods or thickets.

3. **Elytraria angustifolia** (Fernald) Leonard

Elytraria virgata angustifolia Fernald, Bot. Gaz. 22: 169. 1896.
Elytraria caroliniensis angustifolia Blake, Rhodora 17: 131. 1915.
Tubiflora angustifolia Small, Fl. Miami 168. 1913.

TYPE LOCALITY: Thin calcareous soil near Biscayne Bay, Florida. Type collected by A. H. Curtiss (no. 5494).

RANGE: Southern Florida.

Easily recognized by its long, very narrow leaf blades, but in other respects scarcely distinguishable from *E. caroliniensis*. A plant of low swampy regions.

4. Elytraria tuberosa Leonard, sp. nov.

Herba, radicibus tuberiformibus; foliis cum petioli late alato undulato, ovatis, apice obtusatis, basi subcordatis, margine undulato; bracteis oblongis acuminatis.

Acaulescent; roots fusiform-tuberous, 4 mm. thick; leaf blades ovate, 2 to 7 cm. long, 1.5 to 5.5 cm. wide, obtuse at apex, subcordate or occasionally truncate at base, thin, undulate, glabrous except the costa and lateral veins (usually six) which are sparingly pilose; petiole broadly winged, 3 to 15 mm. wide at apex, gradually narrowing to base, the margins undulate; scape up to 4 cm. long, clothed with firm clasping oblong-ovate acuminate ciliate scales about 6 mm. long and 2 mm. wide; spikes solitary or several, terminal, up to 3.5 cm. long and 1 cm. wide; bracts oblong, 8 to 9 mm. long, 2.5 mm. wide, acuminate, firm, faintly 3-nerved, ciliate; bractlets lanceolate, about 5 mm. long, 1 mm. wide, carinate, the keel and margin ciliate; calyx segments lanceolate, 7 to 8 mm. long, 1.5 to 2 mm. wide, acuminate, thin, faintly nerved, pilose at tip, the outermost segment bidentate; corolla 1 cm. long, the tube slender, the upper lip rounded, the lower 3-parted, the segments lobed; capsule oblong, 5 mm. long, 2 mm. broad at base, conical.

Type in the U. S. National Herbarium, no. 1,320,344, collected at El Recreo, Province of Manabi, Ecuador, by H. von Eggers (no. 15405).

Easily recognized by its thin ovate subcordate leaf blades and thickened fusiform roots. This and *E. squamosa* are the only species of *Elytraria* reported from South America.

5. Elytraria shaferi (P. Wils.) Leonard

Tubiflora shaferi P. Wils. Mem. Torrey Club **16**: 111. 1920.

TYPE LOCALITY: Pinelands, Sierra Nipe, near Woodfred, Oriente, Cuba. Type collected by Shafer (no. 3562).

RANGE: Cuba.

Elytraria shaferi is closely affiliated with *E. bromoides*, but can be separated from that species by its small bracts and pilose leaf blades. In *E. bromoides* the bracts (5 or 6 mm. long and 1 mm. wide) taper to a slender point, and the leaf blades are glabrous throughout or the costa and lateral veins sometimes sparingly pilose. The bracts of *E. shaferi* are, in contrast, merely acute and only half as large.

6. Elytraria bromoides Oerst. Nat. For. Kjöbenhavn Vid. Medd. **1854**: 115. 1854.

Tubiflora acuminata Small, Fl. Southeast. U. S. 1082. 1903.

TYPE LOCALITY: Pital, Mexico. Type collected by Liebmann. The type locality of *Tubiflora acuminata* is Texas.
RANGE: Texas, Mexico.

The entire bracts readily distinguish this from *E. squamosa*, the only other species found within its range.

PALEOBOTANY.—*Extension of range of* Attalea olssoni.[1] EDWARD W. BERRY, The Johns Hopkins University.

A single specimen of *Attalea olssoni* sent to me recently by Dr. A. A. Olsson extends the range from near the top of the middle Eocene into the Oligocene of northwestern Peru, and also discloses something of the character of the seeds.

The species was described in 1926 and referred to the genus *Astrocaryum*.[2] Subsequent material which showed more complete

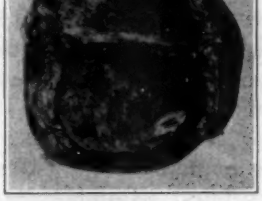

Fig. 1.—*Attalea olssoni* Berry. Natural transverse section.

preservation led to its being transferred to the genus *Attalea*, and the present specimen serves to confirm this identification.[3]

All of the specimens of this species hitherto collected by myself or others have shown no trace of internal structure and have been filled with matrix or partially occupied by crystallized calcite or geodes. The present specimen is a natural section exposing two seeds and clearly indicating that three were normally present. This confirms the identification of the specimens as belonging to the genus *Attalea* instead of to *Astrocaryum* with which they were at first confused.

The present specimen shows the base and peduncle scar and the characteristic surface features corresponding to those shown by the

[1] Received August 20, 1934.
[2] BERRY, EDWARD W. U. S. Natl. Museum Proc. 70[2]: 1, *pl. 1, figs. 1–4*. 1926.
[3] BERRY, EDWARD W. Pan-Amer. Geol. 51: 242, *figs. 4–10*. 1929.

type material from the Restin formation. The distal part of the fruit is gone so that the general form is undeterminable, although it could hardly have been as elongated as in some of the Restin specimens. However there is a large amount of variation in this feature among the latter. It would be possible to differentiate several species if form were considered to have any specific value which, from the actual evidence of the fossils and from the analogous variation in the fruits of Recent palms, it clearly has not.

Among the existing species, of which there are more than a score, there may be 1, 2, or 3 seeds, and in some cases as many as 6 are said to be present. One is justified in considering that 3 seededness is a more primitive condition than a less or greater number.

The present specimen is of interest in addition to the evidence it furnishes regarding the seeds, since it shows a considerable extension of the range. All of the previous specimens were collected from an exposure just south of Punta Arena which was referred to the Restin formation, and is considered to be of late middle or early upper Eocene age.

The present specimen comes from a locality some 20 miles further south in the Chira Valley, northwest of Casa Saman, which is referred to the lower Mirador sandstone of the Mancora formation, and considered to be of Oligocene age.

ETHNOLOGY.—*A negro peyote cult.*[1] Mrs. MAURICE G. SMITH, Bureau of Indian Affairs. (Communicated by JOHN R. SWANTON.)

Those who have been interested in the fortunes of the religious organization revolving about the use of peyote have been alert for indications that it might have taken root at some time either among whites or negroes who live in close proximity to one of the peyote groups. Nowhere has an entire group of white people been found devoting themselves to the cult though frequently individuals have been interviewed who have attended meetings, and who profess devotion in varying degrees to the peyote religion.[2] These persons are usually impressed by the cures that the herb appears to effect. Some have apparently experienced the peculiar state, the nature of

[1] Received June 16, 1934.

[2] Among the notes left by James Mooney in the Bureau of Ethnology is a very interesting manuscript entitled *The peyote road: An exegesis of the religion and mystic rites of the North American Indian*, by C. S. Simmons. Mr. Simmons lived at Cache, Oklahoma and having attended many meetings over a period of years had become well versed in the doctrines of the cult. Chapter VIII on *Physical and psychical phenomena* is particularly interesting.

which has been described by some investigators[3] and which the Indians almost invariably describe as "feeling good." In how many cases this is accompanied by visionary experiences, auditory-visual impressions, or the other sensory illusions mentioned by Klüver,[4] Ellis[5] and others the present state of our knowledge does not permit us to say.

In the fall of 1930 an Iowa Indian gave Dr. Smith a lead regarding a negro peyote group which the writer endeavored to follow up in the spring of 1931. After much fruitless inquiry in both Oklahoma City and Tulsa, Okla., the daughter of the negro leader was finally located in the latter city. Her father, John Jamison, had died in 1926 as a result of concussion of the brain after being struck by "a half-crazed negro." The cult did not survive his death.

From the daughter Mabel it was learned that the cult never became very popular outside of a small group, though now and then the meetings were attended by persons who were attracted by the healing and doctoring which Jamison sometimes attempted just as the Indians do. Even some of the devoted ones became suspicious of the new religion when they learned that the government had taken steps to prohibit the transportation of peyote. "They figured there must be something wrong with it or the government would not prohibit its transportation," Mabel remarked. This attitude on the part of the negroes is doubly interesting in view of the rebellious attitude which the Indians displayed under the same circumstances, and their resort to illegal procedures to obtain peyote.

Jamison was born in Lincoln County, Oklahoma. Both of his parents were evidently alloted and, consequently, Jamison grew up among Indians.[6] He had worked for a number of them, including the Iowa who first gave us the lead, and who seemed to resent the fact that negroes were taking up "the old Indian religion."[7] His daughter claimed that he spoke several Indian languages mentioning particularly Iowa, Pawnee, and Comanche. She also testified to the

[3] KLÜVER, HEINRICH. *Mescal: The divine plant.* London. 1928.
DIXON, W. E. *The physiological action of the alkaloids derived from Anhalonium lewinii.* Journ. of Physiology. 25: 69–86. 1899.

[4] KLÜVER, HEINRICH. *Mescal visions and eidetic vision.* Jour. of Amer. Psychology 37: 502–515.

[5] ELLIS, HAVELOCK. *A note on the phenomena of mescal intoxication.* Lancet, London. 1: 1540–1542.
ELLIS, HAVELOCK. *Mescal: A study of a divine plant.* Popular Sci. Monthly 61: 52.

[6] During the delirium which preceded his death he sang Indian songs and prayed all the time, the nurses in the hospital informed Mabel.

[7] My informant remarked that the older Indians were more friendly toward the colored people than the younger Indians.

fact that he was "some talker" and that he was a devoutly religious man.

The ritual of the negro cult was very similar to the Indian ritual,[8] though there were, of course, some important omissions and more use of the white man's hymns and bible than is customary in Oklahoma. The meeting was continued all night, preferably in an Indian tipi. Jamison carried a canvas cover of his own along with the other paraphernalia which consisted of a drum, sacred dishes for the food served for breakfast, gourd rattle, medicine feathers, cane, sage, cedar and *chief peyote button*. He sometimes dressed in Indian costume, consisting of a feather head-dress (chief's bonnet), blanket, and sometimes moccasins. Whether or not he dressed thus when attending the Indian meetings or only after he himself became a leader and had his negro group, I did not ascertain. Nor do I know how he became a leader. Mabel said he did not become a healer and doctor till about three years before he died, but that he had meetings as far back as "before the riot" (1920, I believe) attended by both Indians and colored people which he sometimes led. At other times an Indian would be the leader. Occasionally the Indians would send for Jamison to lead their meetings.

In the center of the tipi was a fire built in front of an earth crescent. On the center of the crescent mound was the *chief peyote button* which remained there till midnight. At that time the leader ate it. The chief button is never eaten during the Indian ceremony as far as I know. The meetings began between eight and nine o'clock with the members filing in in a prescribed order to certain places. The leader faced the door of the tipi, four "sisters" on his right who took care of the morning repast, and four "brothers" on his left, the first being designated the drummer, the next the cedar man, the other two having no equivalents in the Indian ceremony. The "fireman" was placed at the right of the door and also served as doorkeeper. Jamison always had the same doorkeeper, if possible, which was in line with the relationship existing between an Indian peyote chief and his fireman. The meeting proceeded as follows:

1. The leader sang a song, usually a hymn, but if Indians were present he sang an Indian song. The leader, sitting "goat fashion,"[9] then announced the purpose of the meeting and prayed.

[8] Cf. Günter Wagner's study of the peyote cult entitled, *Entwicklung und Verbreitung des Peyote-kultes*, ein Beitrag zum problem der Akkulturation, Hamburg, 1931.

[9] The manner of sitting while the leader is opening the meeting is considered very important by the Indians. He must sit resting on his knees. This is also the position which everyone must take when eating the peyote any time during the night and is known as "goat fashion."

2. Scripture passage read by the leader or one of the male helpers. Toward morning one of the members talked on this passage.

3. Peyote passed to everyone by one of the sisters and eaten. The order of passing was from right to left. The order among the Indians is from left to right, but Mabel was certain she was correct on this point.

4. Then followed a period of speaking, praying, and singing. Questions of a religious nature might be asked and answered. At midnight the leader ate the chief peyote button, but I do not know whether this was done before or after 5.

5. At midnight the leader burst the heart of the fire. This signified the end of the day and was done in the following manner: As the sticks of the fire burned down the ashes assumed a rough heart shape, though it was very open at one end. While the midnight song was being sung, the leader took the fireman's fire-sticks and made these ashes more heartshaped after which he deliberately destroyed the heart by smoothing the ashes to the sides except for a few live coals with which a new fire was built. In the Indian ceremonies no one but the fireman ever touches the fire.

6. Water which had been standing near the door during the first part of the ceremony was now passed to the chief who drank and passed it right. This was equivalent to the Indian "Midnight water ceremony."

7. A recess for 15 or 20 minutes followed. Participants might leave the tipi via the right and eat fruit or anything else *provided* it was not salty. No Indian ceremony I have attended makes allowance for formal recess though the participants may leave when they desire if they ask permission of the leader.

8. Drummer summoned devotees by beating on the drum when the leader signified that the recess was ended. The rest of the night was spent in singing and praying and eating peyote if anyone wished more. It had been passed perhaps several times before midnight. When the leader saw the sun rising the door was thrown open and everybody stood and sang the closing song which was usually *Till we meet again*, if Jamison was running the meeting. In the Indian ceremony the leader always sings the *Quitting Song* alone. Incidentally, the fire was supposed to be built so that the sun's rays struck the center of the "heart" of the fire. The four sisters then departed, but soon returned with the morning repast which had been prepared the evening before and consisted of four dishes, all of which must be *saltless* and *sweetened*. First there was fruit, then beef prepared in the Indian way, either fresh roasted meat ground up and sweetened, or dried meat soaked, stewed, ground up, and sweetened. Next, cereal or mush and last, dried corn parched, soaked, and sweetened. The order of partaking of these foods does not seem to have been as important as in the Indian ceremonies. The service ended with another drink of water passed ceremoniously as before and "everybody was happy."

The negro ritual differed from the Indian in a few other details. In the first place, there was no ceremonial smoking of cigarettes and very little smoking with cedar. Both of these customs bulk large in most of the peyote rituals. By the latter I refer to the practise of throwing cedar on the fire at intervals and the members wafting the smoke which arises back upon themselves by means of the feathers. Cedar was only put on the fire once in the negro service by the cedar man appointed by Jamison for this purpose. It was done when the first pile of sticks on the fire had burned completely down. Feathers were always part of Jamison's regular equipment but they served more important functions in his "doctor" meetings. The drum was

used for all the singing, but the rattle only for the Indian songs. The leader held the ceremonial cane in his left hand during the entire ceremony, while the Indians pass the cane along with the drum and rattle around the circle to those who sing.

Jamison always took epsom salts Friday night before the meeting on Saturday and a hot bath before going to the meeting. This was in the nature of a purification rite and in line with various similar practises among the Indians.[10] He ate no salt in the evening meal before the meeting. "If these rules were followed they didn't see spooks or crazy things," Mabel remarked.

Further evidence of the syncretization process will be seen in the following confession of faith which was printed and hung framed in Mabel's parlor. All the devoted ones possessed such a form.

David Walker
Director

Our Motto: "The World for Christ"
Christ the Good Shepherd

picture[11]

Church Covenant
of the Church of the First born
"Hebrews 12th Chapter, 23rd verse"

We, the undersigned believers in Christ Jesus, do by virtue of Scriptural Faith submit ourselves to the cause of Christ and the gospel; to live therein; to walk therein; to teach therein; to sing therein; to pray therein; to preach therein; to baptise therein; to observe all the ordinances of Him who has called us to peace, that God may have the glory thereof.

In testimony whereof we the undersigned hereunto set our hands, by virtue of our own free will.

John C. Jamison
Conductor in Charge

Mrs. Lucinda Walker
Mother of the Household of the Faith

Mrs. J. L. Ramsey
Assistant

Katie Hoggins
Secretary of the Household of the Faith

Mrs. Polly Marshall
Assistant

It will be noticed that there is no mention of peyote in this covenant. But this is no different from the practise followed by the Indians in incorporating their peyote cult under the name of the Native American Church. Jamison had not succeeded in getting his group incorporated.

[10] The Osages build a sweathouse as an integral part of their peyote Church set-up. This is situated directly east of the octagonal-shaped church building and still farther east and in direct line with the center of the altar inside the church is the fireplace upon which the stones are heated.

[11] This is a picture of the negro group sitting goat-fashion or standing around the little ceremonial fire. In the foreground may be seen the peyote drum and other paraphernalia.

Those acquainted with the variations in the peyote ceremony in the different tribes, both in and out of Oklahoma, will recognize the many similarities and other differences which I have not mentioned in this interesting attempt to adapt the religious cult of one racial group to the needs of another.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE ACADEMY

257TH MEETING

The 257th meeting of the ACADEMY was a joint meeting with the Philosophical Society, held in the Assembly Hall of the Cosmos Club on Saturday, March 3, 1934. About 115 persons were present. President TUCKERMAN called the meeting to order at 8:20 and introduced Prof. JAMES FRANCK, Nobel Laureate, formerly head of the Second Physical Institute, University of Gottingen. His subject was *Remarks on Catalysis.*

As an introduction, explanations were given of the conceptions: heat of reaction and catalysis.

It is possible, for a few catalytic reactions, to follow the intermediate stages of the reaction and thus to make clear why catalytic reactions do not involve larger heats of activation than is found to be the case. Two types of reactions were presented to illustrate this:

(1) The heterogeneous catalysis of reactions between hydrogen and other molecules on the surface of palladium, nickel, iron, etc.

(2) The catalytic influence of ions of heavy metals in auto-oxidation processes as presented in papers of Franck and Haber, and Haber and Wilstätter.

Type 1.—Coehn has shown that hydrogen absorbed in palladium is dissociated and ionized. This occurs to some extent in nickel and iron. Using a cycle-process, it is possible to calculate the energy liberated by the absorption of protons in palladium. The result is a large excess of energy. To account for the greater part of this energy, it was proposed to assume that there is a condensation of a cloud of free electrons around the proton, analogus to the Debye cloud formation of ions in strong electrolytes. The assumption agrees well with recent determinations of the ratio of the mobility of these ions to their diffusion (Duhm). In accordance with Schmidt, the conclusion was drawn that metals with small values of atomic volume have high values for the heat of condensation of electrons and protons. This heat of condensation is available for dissociation and ionization of the hydrogen in the metallic solution. The metals act as catalyzers because the formation of hydrogen in the gaseous state from the dissolved state takes place very easily. The transition begins with the formation of atoms from protons and electrons. The atoms in the region of the surface are unstable and here react with small heats of reaction with other molecules if these are present, that is, if they are absorbed.

Type 2.—The catalysis of SO_3^{--} ions to SO_4^{--} ions in the presence of Cu^{++} ions was discussed in greater detail. This process explains also the auto-oxidation of organic substances in the presence of Fe^{+++} ions in aqueous solutions.

Cu^{++} and Fe^{+++} ions in water are at their upper limit of stability. Impacts with molecules only slightly less stable than water will produce an exchange of an electron, the metal ion, thereby, having its charge decreased, and the molecule becoming a radical. These radicals react with oxygen forming new radicals, and chain reactions result. The metal ions are oxidized back to their states of higher electric charge. (*Author's abstract.*)

258TH MEETING

The 258th meeting of the ACADEMY was held in the Assembly Hall of the Cosmos Club at 8:15 P.M., on Friday, April 20, 1934. About fifty persons were present. President TUCKERMAN introduced Dr. KURT GODEL, Privat Dozent, University of Vienna, who spoke on the subject, *Can mathematics be proved consistent?*

CHARLES THOM, *Recording Secretary*

RECENTLY ELECTED TO MEMBERSHIP IN THE ACADEMY

ERRETT C. ALBRITTON, professor of physiology, George Washington University, was elected to membership in recognition of his contributions to physiology.

ERNST ARTSCHWAGER, pathologist, Division of Sugar Plants, Bureau of Plant Industry, was elected to membership in recognition of his contributions to plant anatomy and cytology.

NORMAN BEKKEDAHL, assistant chemist, National Bureau of Standards, was elected to membership in recognition of his contributions to electrochemistry and to the thermodynamics of rubber, and in particular of his study of the phase changes in rubber.

PAUL W. BOWMAN, assistant professor of botany, George Washington University, was elected to membership in recognition of his contributions to botany and in particular of his studies of peat bogs.

FREDERICK E. BRASCH, chief, Smithsonian Division, Library of Congress, was elected to membership in recognition of his contributions to the history of science and astronomy, and for the preparation of bibliographies of scientific literature.

RONALD BULKLEY, physical chemist, Socony-Vacuum Corporation, Paulsboro, N. J., was elected to membership in recognition of his contributions to rheology and lubrication, and particularly of his researches on extremely thin films and the thixotropy of lubricants.

BENJAMIN G. CHITWOOD, assistant zoologist, Bureau of Animal Industry, was elected to membership because of his contributions to nematology, parasitology, and animal histology.

VINCENT DU VIGNEAUD, professor of biochemistry, and executive officer, Department of Biochemistry, George Washington University, was elected to membership in recognition of his contributions to the chemistry of carbohydrates, insulin, and cystine and its homologues.

HENRY E. EWING, entomologist, Bureau of Entomology, was elected to membership in recognition of his achievements in the field of applied entomology, taxonomy of mites, and parasitology.

ARNO CARL FIELDNER, chief engineer, Experiment Stations Division, U. S. Bureau of Mines, was elected to membership in recognition of his contributions to the technology of fuels.

GEORGE R. GREENBANK, associate chemist, U. S. Department of Agriculture, was elected to membership in recognition of his studies on the oxidation of fats and oils.

LAWRENCE R. HAFSTAD, associate physicist, Department of Terrestrial Magnetism, Carnegie Institution, was elected to membership in recognition of his contributions to the field of nuclear physics.

FRANCIS E. JOHNSTON, associate professor of mathematics, George Washington University, was elected to membership in recognition of his contributions to the field of algebra and particularly the theory of finite groups.

WENDELL H. KRULL, assistant parasitologist, Bureau of Animal Industry, was elected to membership in recognition of his work in parasitology.

M. B. MATLACK, associate chemist, Bureau of Chemistry and Soils, was elected to membership in recognition of his contributions to phytochemistry.

M. A. MCCALL, principal agronomist in charge, Division of Cereal Crops and Diseases, Bureau of Plant Industry, was elected to membership in recognition of his contributions to agronomy and botany, particularly for his discoveries in the structure of the embryos and young plants of wheat.

EARL B. MCKINLEY, dean of the School of Medicine, George Washington University, was elected to membership in recognition of his publications relating to bacteriophage, immunology, tropical diseases, encephalitis, leprosy and syphilis.

EDWIN T. MCKNIGHT, associate geologist, U. S. Geological Survey, was elected to membership in recognition of his contributions to stratiography and areal geology.

LELAND W. PARR, associate professor of bacteriology, School of Medicine, George Washington University, was elected to membership in recognition of his contributions to the application of immunological methods to the anthropology of the near East and for work with the International Health Board.

EMMETT W. PRICE, parasitologist, Bureau of Animal Industry, was elected to membership in recognition of his contributions to helminthology, especially the taxonomy of trematodes.

CHARLES F. ROSS, director of research, National Recovery Administration, was elected to membership in recognition of his contributions to the mathematical theory of economics.

J. H. ST. JOHN, major U. S. A., director, Department of Protozoology, Army Medical School, was elected to membership in recognition of his contributions in protozoology.

THOMAS D. STEWART, assistant curator, Division of Physical Anthropology, U. S. National Museum, was elected to membership in recognition of his contributions to physical anthropology, particularly Eskimo osteology and primate myology.

LAWSON E. YOCUM, assistant professor of botany, George Washington University, was elected to membership in recognition of his contributions to plant physiology, especially in the field of seed and seedling physiology.

DONNELL B. YOUNG, professor of zoology, George Washington University, was elected to membership in recognition of his contributions in the field of protozoology.

SCIENTIFIC NOTES AND NEWS

Prepared by Science Service

NOTES

Smithsonian Institution.—The Smithsonian Institution commemorated on August 22 the hundredth anniversary of the birth of SAMUEL PIERPONT LANGLEY, for many years its secretary, and noted pioneer in the science of aerodynamics and the art of aviation.

Dr. ALES HRDLICKA, curator of physical anthropology at the U. S. National Museum, led a party of five students in archaeology to renew his explorations of early culture sites on Kodiak island.

AUSTIN H. CLARK, curator of echinoderms at the U. S. National Museum, has re-discovered the long-lost caterpillar of the gold-banded skipper butterfly, which had not been seen since it was first described by JOHN ABBOT in 1790.

Studying the killing effects on algae of eight different wavelengths in the ultraviolet, FLORENCE E. MEIER discovered that each had its own specific "radiotoxic spectral sensitivity," that is, its minimum quantity that would sooner or later result in death. Each wavelength also had a specific "radiotoxic virulence"; that is, the measure of time required to produce the killing effect. The two qualities are not necessarily combined in the same wavelengths.

A large collection of *Plesippus* fossils, from Pliocene strata near Hagerman, Idaho, has been excavated by C. LEWIS GAZIN of the U. S. National Museum. They are being brought here for preparation.

U. S. Department of Agriculture.—Dr. JOHN R. MOHLER, chief of the Bureau of Animal Industry, was elected president of the Twelfth International Veterinary Congress, held in New York City August 13 to 18. Six members of the Bureau presented papers, among them Dr. MAURICE C. HALL, who urged international action in combatting the spread of animal parasites, and Dr. A. E. WIGHT, who upheld the American method of eradication as a means for the control of bovine tuberculosis.

Gonad transplantations had relatively little effect when tried on cattle in a series of experiments performed by Dr. FRED W. MILLER, R. R. GRAVES and Dr. G. T. CREECH of the Department. Their results are not in accord with the claims made for the Voronoff operation on livestock, which has been widely used especially in France and the U.S.S.R.

Implants of normal ovarian and testicular tissue from cattle and pigs were made respectively in cows and bulls of various ages and conditions of health. Results were almost completely negative.

The destruction of all wild mammals except deer over an area of 192,000 acres in Maine, necessitated because of an epidemic of rabies among the foxes, will be made the occasion for a special study by members of the Bureau of Biological Survey, on the response of game and song birds to the total suppression of predators that normally keep their numbers reduced.

The Weather Bureau, with the aid of over 200 temporary employees furnished by the Civil Works Administration, has completed the compilation of a great mass of normal rainfall data for about 4,500 stations, based on the 35-year period 1898–1932. The compilation will probably not be published in its entirety in the near future, but the information is now accessible in Washington to any student who can use it.

U. S. National Park Service.—Director ARNO B. CAMMERER returned to

Washington early in September from the West, where he inspected a number of the parks and monuments. Director CAMMERER has been named to represent the United States on the International Commission on Historical Monuments. This commission was authorized at a conference of experts of the International Museums Office at Athens in 1931, and a working program was approved by the Assembly of the League of Nations in October, 1933.

ROGER W. TOLL, superintendent of Yellowstone National Park, is now in Washington in connection with the preparation of the recreation section of the Natural Resources Board report, which must be in the hands of the President by December 1 of this year. BEN H. THOMPSON of the Service's Wildlife Division at Berkeley, California, is also in Washington aiding with this report.

ELBERT COX, assistant park historian on the Colonial National Monument staff, who has been on detail to the Washington Office for the past year supervising the historical research staff and assisting chief historian CHATELAIN in the preparation of educational programs in the historical parks and other military areas, has been appointed superintendent of the Morristown National Historical Park in New Jersey.

Children's Bureau, U. S. Department of Labor.—A study of the comparability of maternal mortality rates, dealing particularly with similarities and differences in different countries of assigning cause to deaths certified to be associated with pregnancy and childbirth, and the effect of such differences upon the comparability of the figures of the United States and 16 foreign countries has been completed and the report, written by Dr. ELIZABETH C. TANDY, director of the Statistical Division of the Children's Bureau, is ready to go to press.

In an effort to determine the effect of various forms of treatment during the early weeks of life, the child and maternal health division of the Children's Bureau is making a study of the care and treatment of premature infants born at the New Haven Hospital during the past 7½ years. Careful analysis of the cause of death is being made in the case of those infants who died. As approximately half of the 85,000 neonatal deaths occurring each year in the United States are due to prematurity, it is apparent that study of the problem of prematurity and provision of better care of the premature infant are urgently needed.

During the month of September a physician from the staff of the Children's Bureau will examine 200 Indian children in the pueblos near Santa Fe, New Mexico, as part of a three-year investigation being carried on by the Santa Fe Anthropological Laboratories and the Office of Indian Affairs of the Interior Department. The children will be studied from the point of view of growth and development and physical health. In addition special studies of dental development and the incidence of tuberculosis will probably be made. The pediatrician from the Children's Bureau will make the physical examinations and assist with the tuberculosis studies.

Carnegie Institution of Washington.—Arrangements have been made through the Department of Terrestrial Magnetism of the Carnegie Institution of Washington for the latter's Cosmic-Ray Committee, in cooperation with the United States Coast and Geodetic Survey, to install an automatic-recording cosmic-ray meter at the Cheltenham Magnetic Observatory, Maryland, in September or October 1934.

Dr. L. R. HAFSTAD of the Department of Terrestrial Magnetism sailed September 5 to attend the meeting of the International Union of Scientific Radiotelegraphy in London (September 12–19) and the joint meeting of the International Union of Pure and Applied Physics with the London Physical Society, also in London (October 1–6). He will take part in a symposium on nuclear physics during the latter meeting and will present several communications for the Department on investigations of the ionosphere to the former.

Prof. G. GAMOW of the Polytechnical Institute, Leningrad, spoke on some new conceptions of the structure of the nuclei at the Department of Terrestrial Magnetism, September 4 and 10.

Development of standards.—An examination of the first 496 codes approved by the National Recovery Administration reveals that 195 of them, or 41 per cent, have provisions for standards of some sort, according to a report to the American Standards Association, cooperating with the National Bureau of Standards. Ninety-three industries desire standards but have yet to obtain them.

Out of the 496 codes examined, 63 demand standardization on the basis of the work of some government agency. The specific agencies cited as authorities for standards include: the National Bureau of Standards, The American Standards Association, The American Society of Testing Materials, Federal Trade Commission, U. S. Public Health Service, U. S. Department of Agriculture and the Interstate Commerce Commission, together with trade associations which have done prior pioneer work in establishing their own industrial standards.

New type beacon reflector.—The slash in the budget of the Bureau of Air Commerce a year ago led to the development of a new type reflector for airplane beacons which enables a 500 watt electric light bulb to outshine the 1,000 watt bulbs formerly used. Last year the beacons on the Federal Airways system used 1,000 watt, 1,600,000 candlepower lamps with prismatic cover glasses. The order for economy came through and the lamps were changed to 500 watt bulbs. The candlepower went down to 750,000. At the same time, however, the National Bureau of Standards was ordered to investigate ways of increasing the lighting power of the 500 watt lamps. F. CHAPIN BRECKINRIDGE, of the Bureau, made tests on various types of 500 watt lamps, cover glasses and auxiliary reflectors. The final result is a beacon with a 500 watt bulb, plain cover glass and a new type auxiliary reflector which yields 2,000,000 candlepower—about 25 per cent more than the old 1,000 watt bulbs.

Is the United States getting wider?—The distance between Washington, D. C., and San Diego, Calif., showed an apparent increase of about forty feet in 1933 as compared with measurements made seven years earlier. This discrepancy was reported at the meeting of the American Astronomical Society at Connecticut College by C. B. WATTS of the U. S. Naval Observatory. Mr. WATTS stated that he suspected some systematic error; it appears easier for astronomers to make an error of forty feet in measuring a line 3,000 miles long than for the United States to grow forty feet "fatter" in seven years.

News Briefs

Sodium vapor lamps have no special advantages or disadvantages when used by persons engaged in clerical work indoors, Dr. James E. Ives, senior physicist of the U. S. Public Health Service has reported, after a three months' test conducted in New York City. C.W.A. clerical workers participated in the test.

Installation of special radio receivers at filling stations and other points along motor routes to supply autoists with weather information is suggested by the Bureau of Air Commerce. Every hour 68 airways broadcast stations in the United States send out the latest weather news for the benefit of fliers. This information, often valuable for motorists, could be made available by the installation of 200 to 400 kilocycle receivers at places motorists frequent on a cross country trip.

Radio talks given under the auspices of Science Service, over the network of the Columbia Broadcasting System, were as follows: August 15, *Fighting plant diseases*, by F. C. Meier, U. S. Department of Agriculture; August 22, *Can you live without water?* by Abel Wolman, State of Maryland Department of Health; August 29, *Health and the depression*, by George St. J. Perrott, U. S. Public Health Service and Milbank Memorial Fund; September 5, *Is America about to lose her elms?* by Stanley B. Fracker, U. S. Department of Agriculture; September 12, *Harnessing scientific discoveries*, by P. G. Agnew, American Standards Association.

Personal Items

Lt.-Col. Jules Voncken of the medical service of the Belgian Army and director of the Military Hospital at Liège, arrived in Washington September 5 for a three-day visit. He is en route to Tokyo, where he will represent his country at the International Conference of Red Cross Societies. Colonel Voncken visited the Surgeons General of the Army, Navy and Public Health Service, as well as the various Government medical establishments. On September 6 a luncheon was held in his honor at the Army and Navy Club.

Dr. Isaiah Bowman, secretary of the National Research Council, was president of the International Geographical Congress which met in Warsaw during the last week in August. In his presidential address, Dr. Bowman emphasized the need for competent geographic information, if efforts to adjust present mal-distributions of natural resources among nations are ever to receive equitable readjustment.

Prof. John M. Cooper of the Catholic University of America returned early in September from an anthropological expedition among the Indians in the territory east of Hudson Bay. Father Cooper is obtaining from the older members of these primitive tribes a record of the religious beliefs they held before the coming of European missionaries.

Dr. C. F. Marvin, former chief of the Weather Bureau, U. S. Department of Agriculture, retired on August 25, after fifty years' service as a meteorologist. He had been chief of the bureau for twenty-one years.

Dr. C. F. MARBUT, chief of the division of soil survey of the Bureau of Chemistry and Soils of the U. S. Department of Agriculture, who was recently appointed honorary professor of soils at the University of Missouri, left at the end of August for a conference on soils in Barcelona, after which he will participate in an excursion of soil specialists over the Spanish peninsula and part of North Africa. He plans later to spend a few months as adviser on soils to the Geological Survey of China, returning to the United States in the spring, after having spent some time in India.

Obituary

KARL FREDERIC KELLERMAN, principal bacteriologist, in charge of the Division of Plant Disease Eradication of the Bureau of Entomology and Plant Quarantine, in the Department of Agriculture, died August 30, at Washington, D. C. Dr. KELLERMAN was born in Göttingen, Germany, December 9, 1879. After attending Ohio State University, 1896 to 1899, he received the degree of B.S. from Cornell in 1900 and served as assistant botanist at that institution in 1901. Joining the Bureau of Plant Industry in the same year, he served successively as assistant physiologist, physiologist in charge of the Laboratory of Plant Physiology, physiologist in charge of soil bacteriology, assistant chief (1914), and associate chief (1917), remaining in the latter position until 1933 when he took up the work of directing plant disease eradication projects for the Bureau of Plant Quarantine. Dr. KELLERMAN was instrumental in founding the Journal of Agricultural Research and served for 11 years as chairman of its editorial board. During the War he was a member of the National Research Council. He was also a member for a number of years of the Federal Horticulture Board and took an active part in the work of that organization in carrying on plant quarantine activities. In addition to the Washington Academy of Sciences, Dr. KELLERMAN was a member of the American Association for the Advancement of Science, the Botanical Society of America, the Botanical Society of Washington, the Society of American Bacteriologists, the Society of Naturalists, International Society of Soil Science, and Sigma Xi. He received the degree of Doctor of Science from Kansas College in 1923.